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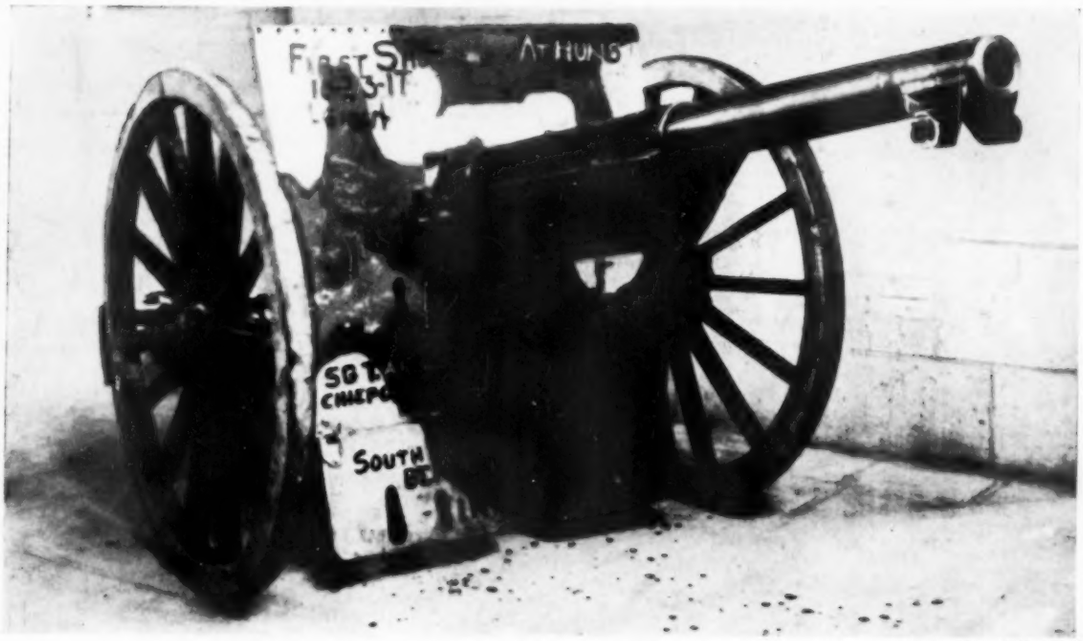

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THE CUTTS COMPENSATOR
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Maj. C. T. Harris, Jr., Ord. Dept., U. S. A.

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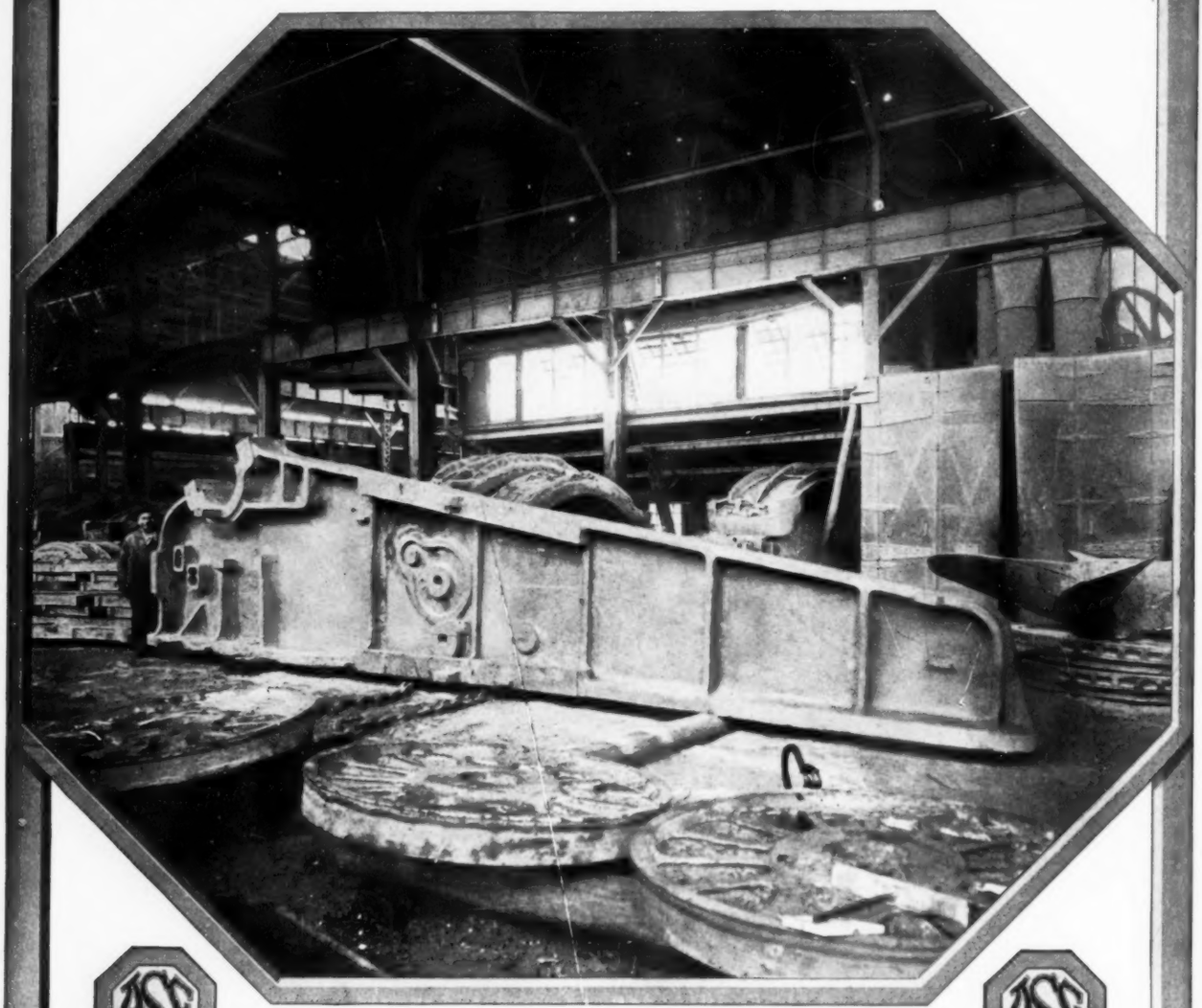

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Hanford MacNider, *Assistant Secretary of War.*

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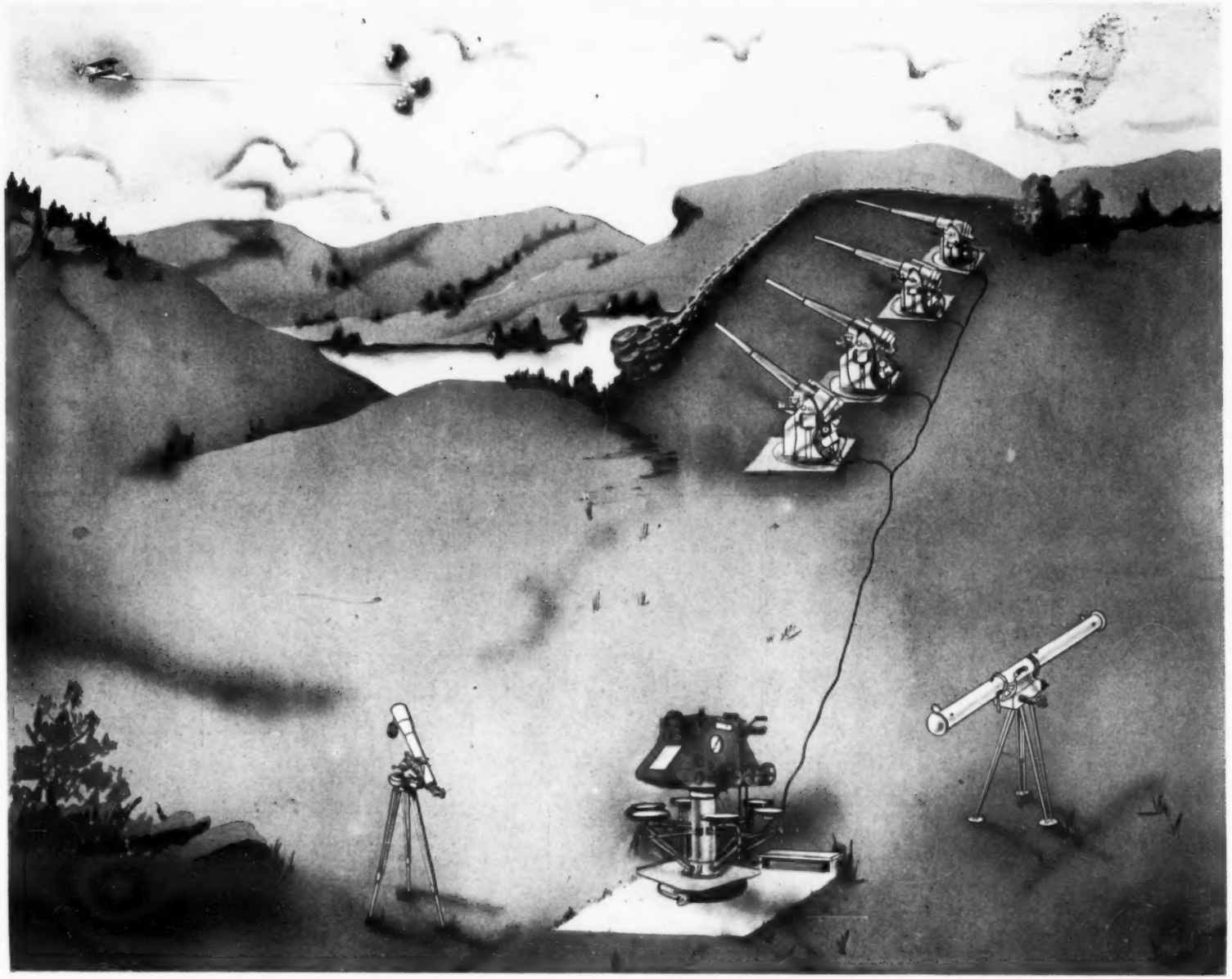


A Battery of Antiaircraft Guns with Latest Fire-Control Equipment.

ARMY ORDNANCE

VOL. VII MARCH-APRIL, 1927 No. 41

Antiaircraft Progress, 1926*

Maj. G. M. Barnes, Ord. Dept. U. S. A.

DURING the winter of 1924 antiaircraft as a means of ground defense against airplanes was being widely discussed in this country, in connection with the controversy raised by Colonel Mitchell of the Air Corps. Many conflicting statements were being made before the Committee of Congress investigating the antiaircraft situation. On March 5, 1925, the following letter was sent by the Chief of Ordnance, U. S. A., to the Secretary of War:

"Subject: Antiaircraft Artillery Target Practices.

To: The Secretary of War.

"1. In presenting the War Department appropriation bill for the fiscal year 1926 to the House of Representatives, Mr. Anthony, from the Committee on Appropriations, stated, as follows:

> 'The committee has reduced the amounts for antiaircraft guns and ammunition and for portable searchlights, but feels that it has provided enough for all practical purposes in view of the doubtful advisability of expending large sums on ground defense against air attack.'

"2. Brig. Gen. H. A. Drum, W. D. G. S., before the House Committee on Military Affairs, stated, as follows:

> '* * * the bomber is outmatched by the antiaircraft artillery at all altitudes which can now be reached by service bombers provided that the target can be seen. It is highly important that this proviso be met.' (Report of the board of officers which conducted antiaircraft gun tests in Hawaii in 1923.)

"3. General Drum also stated:

> 'Gradual improvement in this (target) practice demonstrates that antiaircraft fire against all bomb-carrying planes will be effective.'

"4. It is assumed that General Drum's statements represent the position of the War Department as to the value of antiaircraft guns.

"5. The statements quoted above of Mr. Anthony and of General Drum show a radical difference in opinion between the War Department and the Congress as to the effect of antiaircraft artillery. It seems very probable that this question will be very much alive when Congress reconvenes in December, and it is suggested that as much target practice with antiaircraft guns (at towed targets) as may be possible be conducted between now and the first of December. It is also suggested that there be no limit as to the amount of ammunition which antiaircraft units may consume in this target practice.

"6. The object of these suggestions is to obtain as much additional information concerning the effectiveness of antiaircraft artillery as may be possible between now and the first of December. It is believed that this information will almost certainly be needed.

C. C. WILLIAMS,
Major-General, Chief of Ordnance."

This letter resulted in the approval by the War Department of the antiaircraft tests at Fort Tilden during the summer of 1925. The general plan for these tests was to use the standard antiaircraft weapons in the hands of regular troops, and to fire as large a number of rounds at towed sleeve targets as practicable, during the time scheduled, in order to determine definitely what percentage of hits could be made with existing 3-inch antiaircraft guns, and caliber .30 and .50 machine guns. As far as is known this was the first systematic attempt made in any country to find out exactly what results could be expected when firing antiaircraft weapons at aerial targets; excepting, of course, the actual firings with antiaircraft guns during the World War.

For the Fort Tilden tests the following Ordnance matériel was used:

3-inch Antiaircraft Gun on Auto-trailer Mount, 1918. This is the standard mobile mount (Fig. 1) with which our troops are now equipped. The following fire-control instruments are used for each battery of four (4) guns:

Antiaircraft Data Computer, Model 1917. This is the box-like instrument shown center of Fig. 2.

3-meter Height Finder, Stereoscopic. The height finder (Fig. 2) was the only new fire-control instrument provided for the test. All the rest of the matériel was the same as that issued to the service. Up to that time the height of the target had been determined by means of two altimeters placed at the ends of a long base line. The altimeters, however, were not favored since two observers were required who might observe on different airplanes. The small telescopic instrument on the tripod (Fig. 2) is the wind and parallax computer, which completes the fire control equipment for the battery.

At Fort Tilden there were also two machine gun batteries. Both the caliber .30 and .50 Browning machine guns were mounted on tripods which had been designed just prior to the Tilden tests, and which were hurriedly completed for use during these tests. A barrage type of sight, developed jointly by the Coast Artillery Board and Frankford Arsenal, was also specially manufactured.

Most of you are already familiar with the results of the Fort Tilden tests, but before proceeding with the discussion of the Aberdeen tests, I would like to read extracts from the summary of the final report:

"At present the accuracy of 3-inch gun fire with the 1918 matériel is such that 5 per cent. of hits is to be expected at a slant range of 13,000 feet. The volume and

*The first of the 1926-1927 series of lectures on ordnance and other subjects, Office of the Chief of Ordnance, Washington, D. C.

A Battery of Antiaircraft Guns with Latest Fire-Control Equipment.

Fig. 1. 3-inch Antiaircraft Gun on Auto-trailer Mount, 1918.

accuracy of fire which have been developed by the 3-inch antiaircraft gun battery give an expectation of three hits per battery per minute at 13,000 feet on a single bomber. With machine guns the average range of all firings of the 62nd Coast Artillery Regiment (A. A.) was 1,017 yards with an accuracy of 0.35 per cent. of hits." The Board concludes that "The joint Coast Artillery exercises, though curtailed, were of great value in developing matériel and methods, in determining where improvement is needed, and in furnishing extensive data on which to base sound opinion as to capabilities and present efficacy of the antiaircraft service. In the case of 3-inch guns, machine guns and searchlights, great improvements in design are in progress the cumulative effect of which should be to still further improve the antiaircraft defense."

Aberdeen Tests

It was believed that the new antiaircraft artillery matériel, which had been under development since the World War, would give a higher percentage of hits than could be obtained with the war-time matériel.

The Chief of Coast Artillery and the Chief of Ordnance proposed that as much of the new matériel as could be made available should be given an extensive firing test. The Aberdeen Proving Ground was selected on account of the relatively large safe field of fire, and the proximity of Phillips Field. The War Department approved of these tests provided that funds were not expended for the transportation of personnel. The Chief of Coast Artillery selected the 61st Coast Artillery Regiment (A. A.), commanded by Maj. A. G. Strong, which was transported from Fort Monroe, to the Aberdeen Proving Ground by mine planter. Sufficient personnel was brought to man one 3-inch gun battery, one machine gun battery and one searchlight battery, and a statistical section. Additional officers and men made it possible to assign groups for the period of the tests to the various fire-control systems under test.

Fig. 2. 3-Meter Stereoscopic Height Finder.

Machine Gun Tests

The machine gun tests consisted of firings with the caliber .30 and caliber .50 machine guns mounted on tripods using tracer ammunition without sights, and tracer ammunition with sights and different fire-control systems.

The machine gun tests at Fort Tilden had demonstrated that the antiaircraft tripod provided was slightly unstable with the caliber .30 gun and more unstable with the caliber .50 gun. It was hoped that the new 1925 E2 tripod furnished for these tests would represent a satisfactory solution of this problem. At the completion of the exercises, the regimental commander, Maj. A. G. Strong, C. A. C., in his reports states as follows, concerning the new tripod:

"The 1925 E2 tripod is considered to be satisfactory. Although heavy, it is yet mobile and hence suitable for field use."

The test showed that the vibration was not excessive for either gun, since it permitted bursts of 60 rounds from the caliber .30 gun, and 10 rounds from the caliber .50 gun. It was recommended, as a result of the Aberdeen tests, that this mount be manufactured and issued to the service to replace tripod mounts now in use.

The report of the Fort Tilden Board had recommended the development of rigid mountings for machine guns. Two multiple machine gun mounts having geared control were provided for test at Aberdeen. One permitted the mounting of four (4) caliber .30 or .50 guns, while the other mount accommodated three (3) of these guns. The guns were rigidly mounted on a metal frame, provision being made for slightly elevating or traversing the guns before they were clamped. The metal frame was in turn mounted upon a fixed pedestal and placed on a concrete foundation.

The carriage was provided with open sights so arranged that vertical and lateral deflections could be set off. The ammunition boxes, which were of metal construction, were attached beneath and to the left side of each machine gun. It was found that the multiple mount had several advantages. It was free from vibration; the guns gave a small cone of fire, and each mount delivered a heavy volume of fire.

The several different types of

machine gun sights tested during these practices were the 1925 EE barrage sight, which was the sight used at Fort Tilden, with slight modifications, the simple machine gun sight T-2 (on which lateral and vertical deflections could be laid off) (Fig. 5) and the more intricate Harris machine gun sight T-3 (Fig. 4).

The barrage sight was considered to be unsatisfactory. The simple open sight, T-2, permitting lateral and vertical deflections, was considered the best of those tested.

The data for setting the lateral and vertical deflections on the T-2 sight were obtained from the Frankford Arsenal machine gun computer (Fig. 6), which was constructed for these tests. The slant ranges required by the operator of the data computer were obtained from a short base infantry range finder on an improvised mounting. The machine gun data computer represented an improvement, but did not result in a material gain in the percentage of hits.

Some very interesting panel tests were fired with the caliber .30 and .50 machine guns. With the caliber .30 machine gun mounted on the M 1925 E2 tripod, a panel target was placed at a range of 1,000 yards, and over 2,000 rounds were fired. When the sleeve target (5 ft. x 3¼ ft. x 10 ft.) was placed in the densest part of the pattern 9.3 holes per 100 rounds were found in the sleeve area. A similar test conducted with the caliber .50 machine gun showed 18 per cent. hits at the same range. These results correspond approximately to 36 per cent. theoretical hits for the caliber .30 and 72 per cent. theoretical hits for the caliber .50 gun, as in scoring machine gun fire the holes in the sleeve are multiplied by a factor based on the difference in area between a bombing plane and the sleeve target. These figures represent the maximum percentage of hits which could be obtained with these guns if the center of impact could be kept at all times on the moving target, or, in other words, with perfect fire control. As a matter of fact, the percentage of hits obtained on the moving target at this range was under 2 per cent., showing that the limit of development in machine gun antiaircraft fire-control has not yet been reached.

Considering all machine gun firings at sleeve targets, the average results obtained with the caliber .30 machine gun, using tracer ammunition alone, were slightly better than the results obtained with the different combinations of sight and fire control apparatus tried. The average of hits for the caliber .30 gun, using tracer ammunition, was 1.29 per cent. at an average slant range of 900 yards. The caliber .50 machine gun, tripod mount, sight T-2, and Frankford Arsenal computer, proved to be the best combination and averaged 1.36 per cent. hits at an average slant range of 960 yards.

Fig. 7 shows a comparison of all firings with the caliber .30 and caliber .50 machine guns at Aberdeen Proving Ground with those at Fort Tilden. The curves are plotted to show percentage of hits in terms of slant range. It will be noted that a considerable gain in accuracy has been obtained.

37-MM. GUN TESTS

The 37-mm. full automatic Browning Gun (Fig. 8) was tested for the first time during the summer of 1926 by firing at towed sleeve targets. A small fixed antiaircraft carriage had been provided for mounting the gun. A simple open sight had also been constructed on which lateral and vertical deflections could be set off. The A. A. Director, T2, for 3-inch gun was provided with improvised scales corresponding to the ballistics of the 37-mm. gun and used for furnishing the proper deflections. The height of the target was obtained by means of the 3-meter stereoscopic height finder. The credit for this 37-mm. gun belongs to the late John M. Browning of machine gun fame. It is believed that this weapon represents Mr. Browning's last contribution to automatic cannon design.

The tracer ammunition functioned very satisfactorily, being plainly visible both in day and night firing. The tracer burned well beyond the target and this was found to be somewhat confusing. It was the opinion of the personnel of the 61st Regiment that the length of trace could well be cut down to a time corresponding to a range of about 2,500 or 3,000 yards.

Fig. 3. Antiaircraft Front, Aberdeen Proving Ground, Md.

The report of the 61st Regiment (further stated) that, while the percentage of hits made by the 37-mm. gun was very small, it should be remembered that it would be almost impracticable to obtain hits with only one gun firing on a sleeve target, three feet in diameter, from one to one and a half miles distant, traveling at a high rate of speed. "With a fire unit composed of several guns, a pattern could be obtained which would compensate for the fire control errors. Judging from observation of fire, it is believed that this gun is far more accurate in shooting characteristics than the accuracy of the data computer and height finder, which furnished altitude.

"This gun certainly has shooting characteristics which should enable it to fulfill the mission of furnishing protection from hostile airplanes at altitudes below which the 3-inch gun cannot successfully fire, and above which the machine gun cannot be considered effective."

The object of last summer's tests was to obtain some preliminary data concerning the feasibility of using the 37-mm. gun as an antiaircraft weapon. Undoubtedly with a battery of four or eight guns, using the Case III system of fire control, a satisfactory percentage of hits against a sleeve target could be obtained.

3-Inch Antiaircraft Gun Battery

The Ordnance Department had under manufacture at Watervliet and Watertown Arsenals 3-inch antiaircraft guns and carriages of new design. Here were modern guns and carriages in which the latest improvements had been incorporated. A battery of four of these guns was emplaced at the Proving Ground.

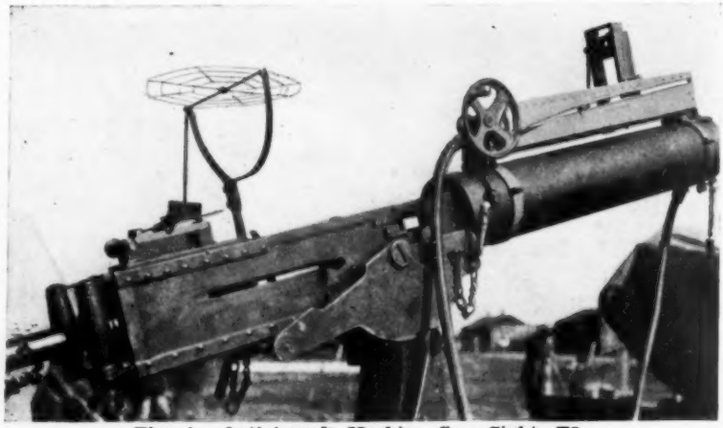


Fig. 4. Antiaircraft Machine Gun Sight, T3.

This antiaircraft gun, which is similar ballistically to the 1917 gun now in service, was designed for a muzzle velocity of 3,000 f. s. with the 15-lb. projectile. On account of the erosion, the velocity was fixed at 2,600 f. s. with the 15-lb. shell or shrapnel, and 2,800 f. s. with the new 13-lb. shell. A new sighting system was provided for this unit. The principal improvement was the practical elimination of all backlash. The power of the telescope was increased from 4-power in 1918 matériel to 8-power. By using a modern wide-angle eyepiece, the large field of 8½ degrees was obtained. The personnel using the new telescope stated that it was superior to the 4-power sight. With the Case III system of fire control, later described, the sighting system is not used. It will, however, doubtless be retained on the modern antiaircraft carriage as the emergency system.

During the tests this four-gun battery was fired over 5,000 rounds. The rate of fire of the battery was at times as high as 108 shots per minute and averaged approximately 80 shots per minute. Very few stoppages occurred. A few firing pins were broken and there were a number of other breakages, but as a whole the guns and carriages functioned throughout the summer with little attention. It is believed that the summer's tests conclusively demonstrated that the 3-inch antiaircraft gun, M1917 MII, and the 3-inch antiaircraft carriage M1917 MI, represent fully developed Ordnance matériel which can be issued to the service with confidence.

Fire Control for 3-Inch Antiaircraft Battery

A large number of fire control instruments for 3-inch guns was provided at Aberdeen for comparative test. Briefly, the test of the fire control instruments resolved itself into a test of the Case I system versus the Case III system, and two central station instruments which stood out from all others, namely, the Director MI and the Frankford Arsenal Director, T-1.

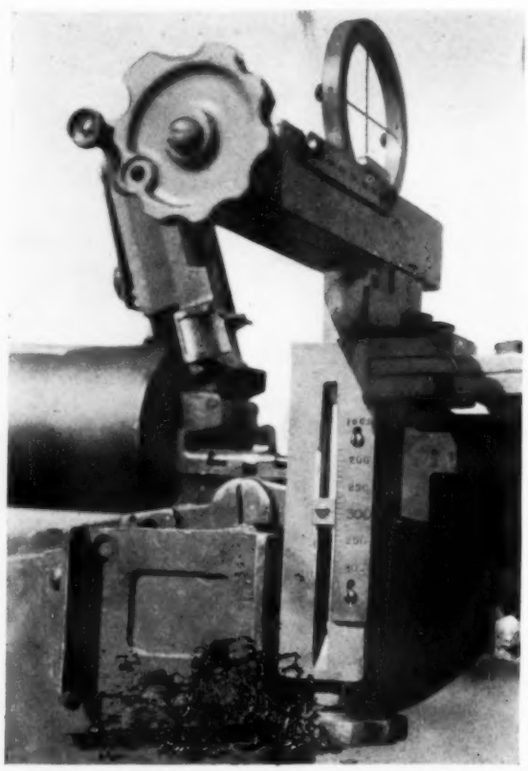


Fig. 5. Antiaircraft Machine Gun Sight, T2.

Case III System of Fire Control

In all antiaircraft firings in this country, until the summer of 1926, the Case I system had been used. That is, the gunner directed the gun at the target, in azimuth and elevation, by means of a telescopic sight. The additional lead required was given by setting off lateral and vertical deflections obtained from the antiaircraft data computer 1917 (Routin). Fuze range was also obtained from the Routin instrument, and, like the deflections, was telephoned to the four guns. In this system much time was consumed in reading, telephoning and setting-off data and eight seconds dead time was added within the instrument to the time of flight of the projectile on this account.

At Aberdeen for the first time a complete Case III system of antiaircraft fire control was tested. A brief description of the Case III system follows.

The height of the target in yards is obtained from the 4-meter stereoscopic height finder (Fig. 9). It is so designed that as long as the target remains at a constant altitude the internal stereoscopic adjustment is maintained provided the instrument is kept trained upon the target. It also has a percentage correction scale and all height readings are automatically corrected by any percentage set off. This feature is essential in connection with the corrections which must be made as a result of trial shot firings. The height read on the instrument is telephoned and set off on the proper scale of the central station director shown in Fig. 10.

This central station instrument is provided with two telescopic sights by means of which the target is followed accurately in azimuth and angular height. The central station instrument, which is a super-computing machine,

solves the geometrical and ballistic problems involved. The instrument automatically computes the future position of the target based on the angular rates of change in azimuth and elevation. It automatically multiplies these rates by the time of flight of the projectile. It automatically makes all ballistic corrections. Thus the instrument is able to give continuously the azimuth, quadrant elevation, and fuze range corresponding to the future position of the target.

TRANSMISSION SYSTEM

Instead of telephoning the data obtained from either of these instruments, an electrical transmission system transmits the information directly to the four guns.

As the director follows the target, one set of pointers, operated by the transmission system, on the receiver moves continuously. The receiver is geared mechanically to the gun carriage so that in order to keep the gun set in azimuth, it is only necessary to keep all the pointers matched. The smallest reading on the receiver dial is one mil. A similar receiver is mounted on the elevation side of the gun. Thus with the Case III system, no sighting system is required. In the Case I instrument the fuzes were set by means of the bracket fuze setter M 1916. The Case III system necessitated the design of a new fuze setter so that the fuzes could (like the gun) be continuously set by the follow-the-pointer method.

The operator keeps the fuze setter continuously set by matching his pointer with that controlled from the director. The setter is so designed that the fuze can be turned either in an increasing or decreasing direction. In this arrangement, the only dead time remaining in the system is that required to withdraw the projectile from the setter, insert it in the gun and fire. Thus the dead time has been reduced from the eight seconds allowed in the Case I system to one second for the Case III system.

Fig. 6. Frankford Arsenal Data Computer for Cal. .50 Machine Gun.

With Case I a bomber flying 100 miles per hour would travel about 400 yards in eight seconds dead time, but only about 50 yards in one second dead time. After the dead time has been determined upon it can be set back in the central station computer, and all readings corrected by that amount.

The chief advantages of the Case III system may be summarized as follows:

It removes four gun pointers from the four gun sights.

It removes all telephones and the personnel errors and confusion incident to telephoning data.

It removes all errors due to reading scales and setting off these readings.

It reduces the dead time to one second.

It permits the gun to be continuously set on the future position of the target, instead of intermittently as is the case if lateral and vertical deflections are applied.

The results obtained with the Case III system fully met all expectations and resulted in a much larger percentage of hits than was obtained at Fort Tilden, as will be shown later.

Very briefly, the recommendations of the Commanding Officer of the 61st Regiment, concerning the matériel pertaining to the 3-inch antiaircraft battery were as follows:

"The gun and mount comprise a unit embodying all the known desirable elements for a fixed antiaircraft gun. Rates of fire as high as 27 rounds per gun per minute

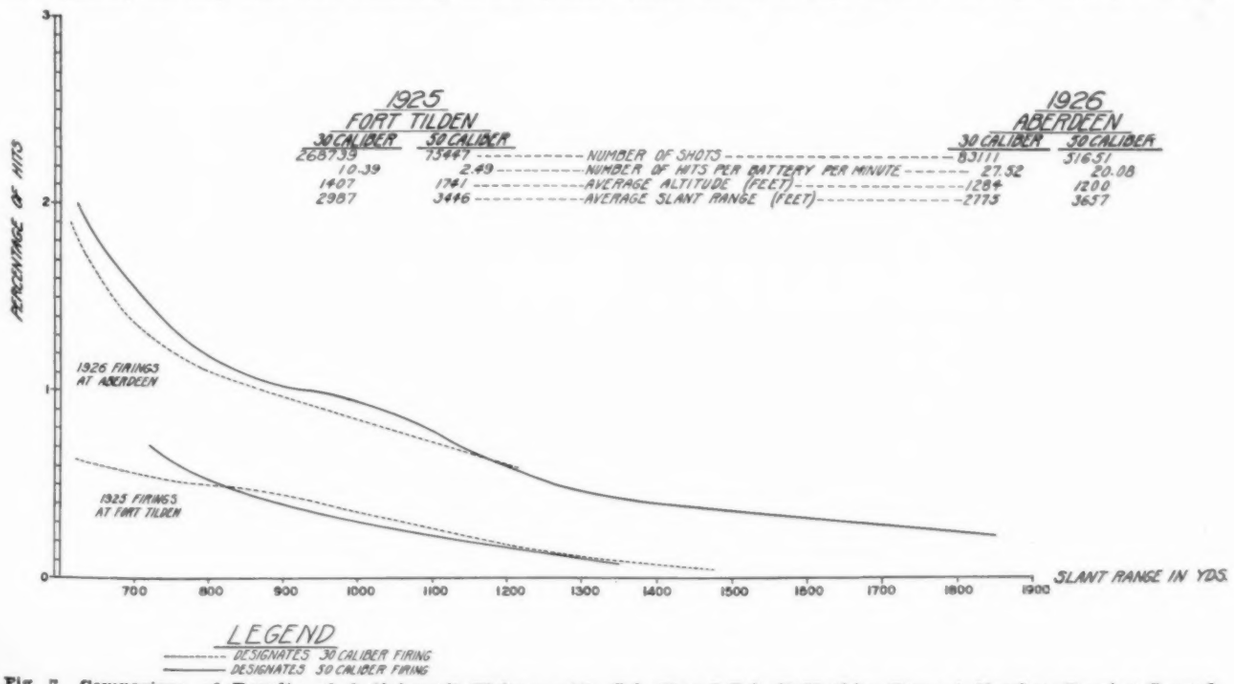


Fig. 7. Comparison of Results of Antiaircraft Firings with Cal. .30 and Cal. .50 Machine Guns at Aberdeen Proving Ground, 1926, with those at Fort Tilden, 1925.

Fig. 8. 37-mm. Gun, Browning Automatic, Model 1925.

were repeatedly maintained over courses of considerable length. Only minor changes are necessary, and the entire mount is considered satisfactory as a standard of manufacture."

Recommendations concerning the sight are as follows:

"That the minor changes recommended be adopted: that the system as modified be adopted as a standard of manufacture for this type of artillery."

The conclusions of the Board, after extensively testing the stereoscopic height finder and altimeters, both during target practice and against the camera obscura and the mirrors for accuracy, follow:

"The stereoscopic height finders are not as accurate as the altimeters M 1920, providing the altimeters are properly oriented and operated, but each stereoscopic observer has an error depending on the slant range and altitude, which can be determined by mirror reading and thus be expected and allowed for and thus improve the stereoscopic readings. From all results in this test the stereoscopic height finders can be considered as a satisfactory substitute for the altimeter M 1920 for the following reasons:

"They are easier of installation and surer of operation. The errors of the observer can be determined from the mirrors and curves plotted and the readings adjusted for accuracy. They can give range sensings which are necessary for fire adjustment. They give data continuously. There are no errors in transmission or communication. It is recommended that the 4-meter stereoscopic height finder T-2 be adopted as a standard of manufacture and issued to the gun battery, pending the development of a better instrument."

Continuous Fuze Setter T-1

"Weighing all factors, it appears that the T-1 fuze setter is one of the most valuable additions to antiaircraft yet devised. The production of abnormal rounds should be eliminated, but should this be impossible it is believed that the T-1 fuze setter, with a certainty of 5 per cent. abnormal rounds, is far superior to the bracket fuze setter M 1916 from which 1 per cent. abnormality is to be expected." After making certain recommendations in regard to suggested modifications, the report further recommends "that with the above modifications the production of T-1 fuze setters for all guns and ammunition is urged."

The Board states that Case III is considered the best method of pointing antiaircraft batteries, and recommends that future development of antiaircraft fire control be based on Case III methods.

3-Inch Antiaircraft Gun With Torque Amplifier

It has been pointed out that the Case III system of fire control, with electric data transmission, makes it possible to keep the gun laid in azimuth and elevation corresponding to data computed by the central station instrument, with the minimum loss of time and small personnel errors.

It would be ideal if the men employed in setting the gun in azimuth and elevation by matching pointers, and the fuze setter, could be eliminated and the gun and fuze setter automatically operated. This now appears practicable through the development of the torque amplifier.

Fig. 11 shows this device with cover removed installed on the elevating mechanism of the 3-inch antiaircraft gun. A similar device is also attached to the traversing mechanism. The cable coming from the central station instrument can be seen entering the device. The power for elevating and traversing the gun is supplied by one-half horsepower motors, which form a part of each device. Except for the electrical data transmission, which is the same as that used for Case III, the device is wholly mechanical.

Up to the present writing it has not been fully tested due to mechanical difficulties. However, several shots have been fired while the gun was being moved in azimuth and elevation by the device, controlled from the central station instrument Director T-1. After these firings the elevation and azimuth of the gun were compared with the elevation and azimuth of the sights of the central station instrument by bore-sighting the gun and sighting the telescopes on a distant datum point. The greatest angular variation was 2 mils. While the device must be further tested, and various parts undoubtedly strengthened, it now appears

Fig. 9. 4-Meter Stereoscopic Height Finder, T2.

Fig. 10. Antiaircraft Director, T1.

that in the very near future only the loading detail will be required at the antiaircraft gun to handle the ammunition from the fuze setter to the gun. A further improvement in antiaircraft fire should result due to the elimination of all personnel errors at the gun carriage.

105-MM. ANTIAIRCRAFT GUN AND CARRIAGE

The new 105-mm. antiaircraft gun and carriage M 1926 arrived at the Aberdeen Proving Ground during the period and were partially tested. The gun, which is 60 calibers long, was designed for a muzzle velocity of 3,000 f. s., but was tested at a velocity of 2,800 f. s. Whether a muzzle velocity of 3,000 f. s. can be used for this gun will depend entirely upon the rate at which erosion takes place. Since the complete round for the 105-mm. antiaircraft gun weighs 67-lbs., it was necessary to provide the carriage with an automatic rammer mechanism. The rammer mechanism is so constructed that it is thrown to the rear during the recoil of the gun, compressing the air in the rammer cylinder. To load the gun it is only necessary to place the compiete round on the loading tray attached to the breech end of the gun, placing the head of the cartridge in front of the rammer. When the rammer level is pulled, the air forces the rammer and the round of ammunition forward into the gun. The gun is equipped with semiautomatic breech mechanism which closes as soon as the round of ammunition is pushed home at the same time locking the rammer head out of position. As the weight of the projectile for the 105-mm. antiaircraft gun is 33-lbs., the danger space of the high explosive shell should be considerably greater than that of the 15-lb. shell for the 3-inch gun. The maximum ceiling of the 105-mm. gun is approximately 35,000 feet, while the maximum range is 19,000 yards. The advantage of the 105-mm. antiaircraft gun over the 3-inch gun lies not only in the increased danger space of the shell, but also in a reduced time of flight at all ranges. The test of this gun could not be completed during the time allowed for the exercises due to the difficulties experienced with some of the mechanical features of the carriage. The tests of the gun and carriage are now being continued at the Proving Ground.

Fig. 12 summarizes the results of the 3-inch gun firings at Aberdeen. The curves show the results of these two intensive antiaircraft tests, and are based on approximately 5,000 rounds of 3-inch shrapnel fired at towed targets at various ranges. The dotted line shows the percentage of hits in terms of slant range obtained at Fort Tilden with 1918 matériel. Thus, at an average range of 4,000 yards the curve indicates 5 per cent. hits. At the same range about 13 per cent. hits were obtained with Case I or Case III at the Aberdeen Proving Ground. At 5,000 yards slant range the percentage of hits at Fort Tilden was 2 per cent., while with Case III it was 10 per cent. at Aberdeen.

It will be noted that the difference between the results obtained with Case I and Case III is much greater at the longer range than the shorter range. Beyond 5,000 yards, when using Case I, the gun pointers cannot see through the smoke haze surrounding the gun, after the first few rounds of fire. In the Case III system the A. A. Director is far enough removed from the battery to permit ready observation of the targets.

The curves shown in Fig. 13 indicate the relative battery efficiency. The lower curve is plotted from the results obtained at Fort Tilden, in terms of slant range and hits per battery per minute. The upper curve shows the results obtained with the battery at the Aberdeen Proving Ground, when using Case III fire.

Thus at 4,000 yards slant range, which is the average range of the Fort Tilden tests, about three hits per battery per minute were obtained. At Aberdeen at the same range, using Case III, ten hits per battery per minute were obtained. Beyond 5,000 yards at Fort Tilden the hits per battery per minute approached zero, while at Aberdeen there were approximately eight hits per battery per minute.

It is realized that this summary of the antiaircraft tests at Aberdeen during the summer of 1926 is inadequate, and that many important projects and phases of the test have been omitted.

In conclusion, while the Aberdeen antiaircraft tests were primarily intended for the test of matériel, it is believed

Fig. 11. 3-inch Antiaircraft Gun, Model 1917, on Mount Equipped with Torque Amplifiers.

that they furnished an unusual opportunity for training the 61st A. A. Regiment. More than this, the tests put the Artillery service in intimate contact with the new antiaircraft matériel, and made it possible for them to pass judgment, after extensive field tests, not only on the details but also on the general trend of antiaircraft development. Under the usual course of events it would have been several years before this matériel could have reached the using service for test.

Too much praise cannot be given the personnel of the three corps concerned for the splendid spirit of cooperation which existed between them. The 49th Bombardment Squadron, under Maj. Harold Geiger, Air Corps, cooperated to the fullest extent. The tests required 292 flying hours. Targets were promptly furnished when required, day or night. In addition, the pilots displayed a personal interest in the tests and endeavored to fly the course requested. Not a single injury to Air Service personnel occurred, although many flights were conducted under unfavorable conditions.

The test program was most efficiently carried out by the 61st A. A. Regiment, under Maj. A. G. Strong, C. A. C. Its report of these tests form, in my opinion, the best treatise on antiaircraft artillery fire now in existence. If similar intensive tests of antiaircraft artillery matériel can be held over a period of years, the rapid development of the art of antiaircraft fire is assured.

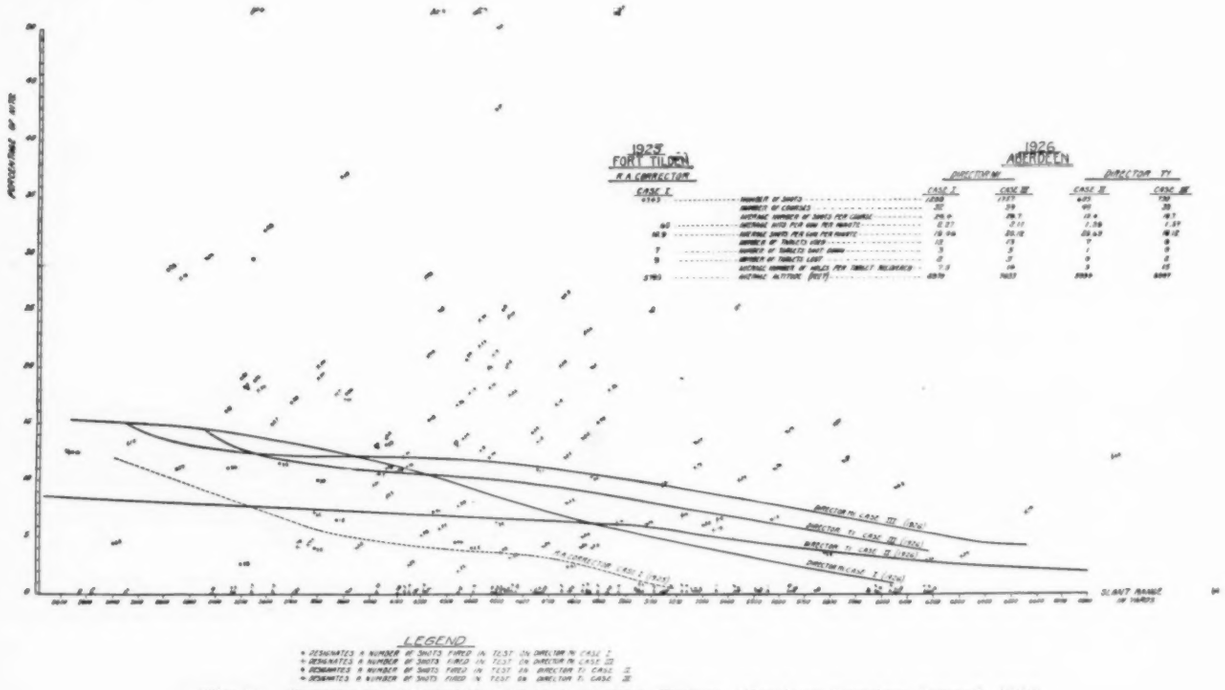


Fig. 12. Summary of Results, 3-inch A. A. Gun Firings, Aberdeen Proving Ground, 1926.

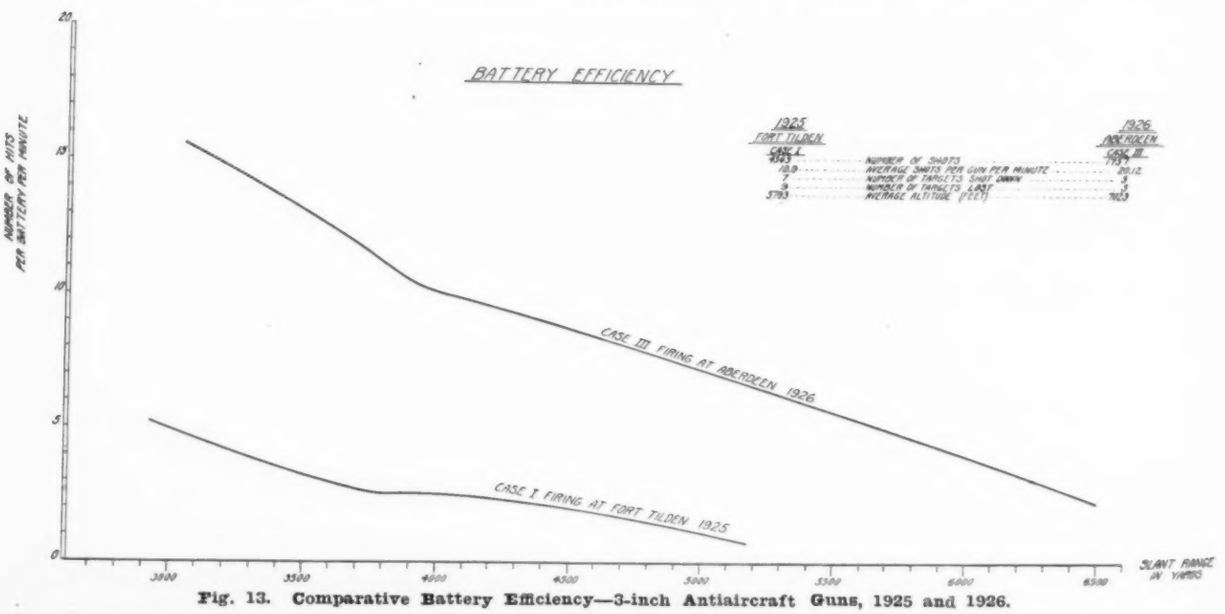


Fig. 13. Comparative Battery Efficiency—3-inch Antiaircraft Guns, 1925 and 1926.

The Cutts Compensator*

Philip P. Quayle

THE compensator[1] is a device to be attached to the muzzle of small arms or ordnance[2] for the purpose of overcoming the tendency to "climb" by reducing the kick and holding the muzzle down. It acts by diverting part of the blast gases backward and upward so that the resulting reaction pushes the compensator, and the muzzle to which it is attached, forward and downward.

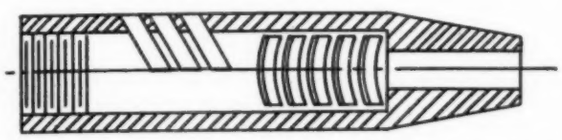


Fig. 1. Sectional View of Most Efficient Form of Compensator.

The most efficient form of the caliber .30 compensator is shown in section in Fig. 1. A number of ports are milled in the long cylindrical portion of the device and usually these ports are all turned backward through the same angle, which is made as great as is consistent with the maximum reaction and the service of the piece. All of these ports assist in reducing recoil but the upper ports exert a downward thrust on the muzzle. This downward component may be varied in magnitude by changing both the number and the position of the upper ports and is different for each arm to which the device is fitted.

When the bullet has left the muzzle but has not yet emerged from the compensator, the gas in the compensator is at high pressure and blows through the ports at high velocity; and even after the bullet has got clear away, this action continues with reduced value, the gases blowing through the ports as well as through the front end. Thus the compensator does not become effective until the reaction of the bullet is nearly finished, so that the jerk backward is followed by a somewhat less sudden jerk forward and downward. But the whole time required for the discharge is so short that in practice the two effects are merged into one and the net result is to cushion the recoil and hold the muzzle down.

Since it is obviously impossible to give any adequate mathematical theory of the behavior of the gases, the design of the compensator had to be developed principally by a cut-and-try method guided by mechanical principles and the results obtained from the recording apparatus.

General Theory

The velocity of free recoil of a given piece is usually computed by means of the formula

$$V = \frac{(m + C\,n)\,v}{M} \qquad (1)$$

where m = mass of the projectile
M = mass of the piece
n = mass of the gas
v = velocity of the projectile
V = velocity the piece would acquire if perfectly free to move
C = a constant determined by experiment

If we assume that all the powder is converted into gas and that it is uniformly distributed throughout the bore, then at the instant at which the projectile clears the muzzle $C = 1/2$ and equation 1 becomes

$$V = \frac{(m + \tfrac{1}{2}\,n)\,v}{M} \qquad (2)$$

At any later time the phenomena are too complex and too imperfectly understood to permit us to say much about them, and all we can do is to determine the effects of the gas without attempting to explain in detail how they come about. With this understanding we may represent by "u" a purely fictitious value (to be determined later) for the velocity of the powder gas, which must be applied to satisfy the equation of momentum.

$$V = \frac{mv + nu}{M} \qquad (3)$$

When the gas moves in the same direction as the projectile its momentum acts to increase the velocity of recoil of the piece. If, however, it were possible and feasible to turn all of the gas backward through an angle of 180° then its momentum would be subtracted from that of the projectile and the velocity of the recoil of the piece reduced in accordance with the formula

$$V_{180} = \frac{mv - nu}{M} \qquad (4)$$

Formulae (3) and (4) for the maximum and minimum velocities of recoil theoretically possible permit us to write the expression for the maximum percentage reduction "R" in the kinetic energy of recoil which is

$$R = 1 - \frac{\tfrac{1}{2}\,MV^2_{180}}{\tfrac{1}{2}\,MV^2} = \frac{\tfrac{1}{2}\,MV^2 - \tfrac{1}{2}\,MV^2_{180}}{\tfrac{1}{2}\,MV^2} \qquad (5)$$

$$= \frac{(mv + nu)^2 - (mv - nu)^2}{(mv + nu)^2} \qquad (6)$$

It is evident from equation (6) that R is a maximum when mv—nu=O, that is when the backward momentum of the gas equals the forward momentum of the projectile. This condition is of course never realized in practice but if it could be the total reaction on the piece would be zero.

*Published by permission of the Director of the National Bureau of Standards of the U. S. Department of Commerce.

[1]The Cutts Compensator is an invention of Col. Richard M. Cutts, U. S. Marine Corps, and 2nd Lieut. Richard M. Cutts, Jr., U. S. Marine Corps.

[2]Editor's Note: The term "ordnance" in this paper is used to designate guns of field caliber and larger.

Equation (6) also shows that the percentage reduction in the kinetic energy of recoil is independent of the mass of the gun, in so far as it does not affect "v" and "u" appreciably.

It is true, of course, that the lighter the gun—other factors remaining equal—the greater its velocity and hence its kinetic energy of recoil. This fact, however, has no effect upon the percentage reduction. Thus we see that if the mass of a particular gun, fitted with the compensator, is lightened somewhat, the kinetic energy of recoil will increase but the percentage reduction when the compensator is attached will remain unchanged.

The reaction of the gas is, of course, proportional to its vector change in momentum. In general we cannot use all the gas since some escapes at the muzzle of the compensator and only a portion "K" escapes at the ports.

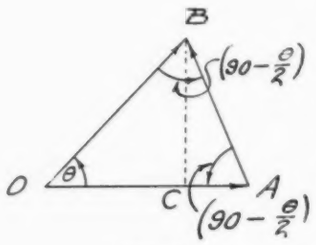


Fig. 2.

If in Fig. 2 we represent by the vector "OA" the momentum of that portion of the gas which is deflected through some angle "θ" by the ports of the compensator, then the vector change is "AB," the value of which is

$$\overline{AB} = 2\ \overline{OA} \sin \frac{\theta}{2} \qquad (7)$$

The rearward component of the vector, $\overline{AB}$, is

$$\overline{AC} = \overline{AB} \cos \left(90 - \frac{\theta}{2}\right) \qquad (8)$$

$$= 2\ \overline{OA} \sin^2 \frac{\theta}{2} \qquad (9)$$

If we replace the vector $\overline{OA}$ by its value Knu we may write for the velocity of recoil of the piece in general

$$V = \frac{mv + nu - 2\ Knu \sin^2 \frac{\theta}{2}}{M} \qquad (10)$$

$$= \frac{mv + nu\left(1 - 2\ K \sin^2 \frac{\theta}{2}\right)}{M} \qquad (11)$$

The tendency of a gun muzzle to move upward, in all cases where the center of gravity is below the axis of the bore, is of course due to the turning moment of the force of recoil. If the recoil is diminished the tendency to "climb" will also diminish. However, in addition to the reduction in the velocity of recoil as set forth in equation (11), the gas in escaping from the ports communicates a certain momentum whose component in a downward direction is the vector $\overline{BC}$

$$\overline{BC} = \overline{AB} \sin \left(90 - \frac{\theta}{2}\right)$$

$$= 2\ \overline{OA} \sin \frac{\theta}{2} \cos \frac{\theta}{2}$$

$$= 2\ Knu \sin \frac{\theta}{2} \cos \frac{\theta}{2} \qquad (12)$$

Tests of the Compensator

We shall now explain briefly, first, our experiments to determine the reduction in recoil and, second, those carried out to determine the downward component necessary for the control of an automatic rifle.

The percentage reduction in the kinetic energy of recoil of the caliber .30 Springfield fitted with the compensator was obtained by two independent methods. The first determination was made with a spring dynamometer and the second with a special ballistic pendulum.

1. Spring Dynamometer. In this apparatus the piece was held in a light iron frame which somewhat augmented its mass. In recoiling, a calibrated spring was stretched to some distance "X," say, and recorded by a stylus attached to the frame. It is, of course, true that when the mass of the piece is increased, as in this case, the kinetic energy of recoil is very much reduced from that experienced under service conditions. However, the *percentage reduction* of the kinetic energy of recoil as determined with the dynamometer is the same as that under service conditions as shown by equation (6).

Suppose the spring to be under no initial tension, then, when stretched to some distance "X" the force "F" = KX, where "K" is the scale of the spring. The average force is then

$$F = \frac{KX}{2} \qquad (13)$$

The work done is therefore $W = \frac{KX^2}{2}$ (14)

Hence we see that the work, and therefore the energy, increases as the square of the distance through which the spring is stretched. It is evident therefore that if a gun recoils twice as far with one charge as with another it is very misleading to say that the amount of recoil with the one charge is twice as great as with the other. In reality the amount of work done (energy communicated to the spring) in the two cases under consideration is in the ratio of four to one.

In order that the masses included in each case might be the same, a mass of solder equivalent to that of the compensator was attached to the muzzle when firing without the device.

With the apparatus as described above, except that the dynamometer spring was under an initial tension, the following typical observations were obtained.

Work done with and without the compensator attached to the caliber .30 Springfield, (150 grain bullet):

Without the Compensator	With the Compensator
Recoil distance = 0.361 ft.	Recoil distance = 0.236 ft.
F_1 = 6.6 lbs.	F_1 = 6.6 lbs.
F_2 = 26.2 lbs.	F_2 = 19.4 lbs.
$F_{avg.}$ = 16.4 lbs.	$F_{avg.}$ = 13.0 lbs.
W_1 = (16.4) (.361)	W_2 = (13.0) (.236)
= 5.92 ft. lbs.	= 3.07 ft. lbs.

Percentage reduction $R = \frac{5.92 - 3.07}{5.9} = 48$ per cent.

The same device showed the same percentage reduction for the 172 grain bullet.

Fig. 3. Determining Effect of Compensator by Ballistic Pendulum.

The reduction in work done in the case just given is not the maximum that can be obtained, but is that obtained with one of the early devices under the conditions of the experiment.

Judging from the general consensus of opinion of those who have fired only a few shots from the Springfield, with and without the compensator attached, the reduction in recoil is always underestimated. However, if twenty rounds of say, National Match cartridges are fired it will be evident that the compensator eliminates most of the real punishment. Possibly the physiological and psychological effect of recoil is proportional in some way to the rate at which energy is absorbed by the shoulder of the rifleman.

2. BALLISTIC PENDULUM. With the ballistic pendulum shown in Fig. 3, a second determination was made of the effect of the compensator on the caliber .30 Springfield.

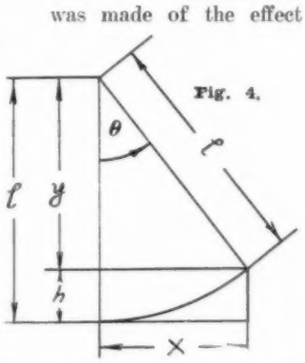


Fig. 4.

In Fig. 4 let

l=length of the pendulum
x=measured displacement due to recoil
θ=angle through which the pendulum is rotated.
M_b=mass of the pendulum.

To be absolutely correct M_b should, of course, include ½ mass of the suspending wires and a correction factor for the mass and friction of the slider. However, the error thus introduced is negligibly small. The height h, through which the bob of the pendulum is raised, is therefore

$$h = l - y = l\,(1 - \cos\theta) \qquad (15)$$

where $\theta = \sin^{-1}\frac{X}{l}$ (15a)

Knowing "h" we may now compute the velocity of the bob at starting, which is the same as it would acquire in falling through a distance "h." Hence the maximum velocity of the bob is

$$V_b = \sqrt{2gh} \qquad (16)$$

and its momentum is equal to the right hand member of the equation

$$M_b V_b = mv + nu \qquad (17)$$

where M_b and V_b are respectively the mass and maximum velocity of the pendulum bob. In our experiments the pendulum bob consisted of the rifle and its supporting frame work. For the service mass of the rifle alone, we have for the velocity of recoil

$$V = \frac{M_b V_b}{M} \qquad (18)$$

In the actual experiment the symbols had the following values:

Weight of bob=36.44 lbs. $M_b = \frac{36.44}{32.2}$ in gravitational units.

Weight of rifle=8.81 lbs. $M = \frac{8.81}{32.2}$ in gravitational units.

l = 277.2 cms.

The displacement "X" was obtained as indicated below for 150 grain bullets.

Without Compensator

Shot	Zero	2nd reading
1	19.5 cms.	53.6 cms.
2	.5	.5
3	.5	.3
4	.5	.4
5	.5	.7
6	.5	.3
7	.5	.4
8	.5	.2
9	.5	.2
10	.5	.3
	19.50	53.39
		19.50
		x_1 = 33.89 cms.

With Compensator

Shot	Zero	2nd reading
11	19.5 cms.	44.9 cms.
12	.5	44.9
13	.5	45.2
14	.5	.1
15	.5	.0
16	.5	.6
17	.5	.2
18	.5	.5
19	.5	.2
20	.5	.2
	19.50	45.18
		19.50
		x_2 = 25.68

Spark Photographs Of Cutts Compensator

Fig. A.

Fig. B.

Fig. C.

THE six photographs of the Compensator of the caliber .45 Thompson Sub-machine gun were obtained by a method of spark photography previously described by the author. (Bureau of Standards Scientific Paper No. 508, "Spark Photography and its Application to Some Problems in Ballistics.")

The gas which seems to obscure the sights in the accompanying photographs is actually colorless. The escaping gas is recorded on the film because its density is different from that of the surrounding air.

FIG. A. *Compensator for the caliber .45 Thompson Sub-machine gun. The cartridge has been fired and the bullet has not yet reached the compensator but is still in the barrel of the gun. The gas seen just ahead of the muzzle of the compensator and over its ports consists of leakage gas and air which has been pushed out of the barrel.*

FIG. B. *The bullet is now out of the muzzle and in the compensator as evidenced by the heavy sound or blast waves seen just ahead of the compensator muzzle and over its ports. The general character of the phenomenon due to the high pressure of the gas blast is now entirely different from that in Fig. A. When the bullet emerges from the muzzle the gas of the propelling charge is released and immediately rushes into the compensator where some of it escapes at the*

On Caliber .45 Thompson Sub-Machine Gun

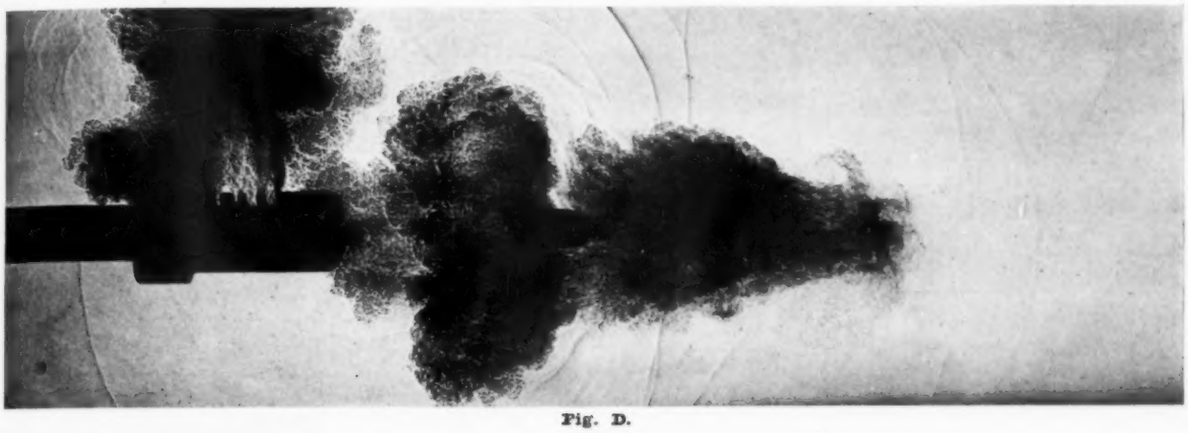


Fig. D.

Fig. E.

Fig. F.

muzzle of the device but a large portion of it escapes at the upper ports. It is the reaction due to the gas escaping from these ports which holds the muzzle down.

FIG. C. *The bullet is about to emerge from the muzzle of the compensator. While passing through the small front cylinder of the compensator the bullet virtually stops the escape of gas from the muzzle thus momentarily raising the pressure of the gas at the ports. The distortion in the sound waves seen over the ports and ahead of the muzzle is due to the fact that the velocity of the gas is greater than that of sound in the surrounding gas medium.*

FIG. D. *Two clouds of gas have emerged from the muzzle of the compensator, one preceding and one following the bullet. The volume of gas escaping from the ports appears to be considerably greater than the gas cloud following the bullet.*

FIG. E. *A slightly later stage of Fig. D showing a larger volume of gas over the ports which are operating strongly. The bullet is beginning to move ahead of the gas blast which, of course, encounters great resistance in expanding in air.*

FIG. F. *The bullet is now about 10 inches away from the muzzle. Most of the gas is now exhausted, although the ports are still operating to a certain extent.*

From these measured displacements the maximum recoil velocity of the entire pendulum may be calculated as follows:

From equation

$$(15a)\quad \theta_1 = \sin^{-1}\frac{33.89}{277.2} = 7^\circ\ 1'\ 20''$$

$$\theta_2 = \sin^{-1}\frac{25.68}{277.2} = 5^\circ\ 19'\ 0''$$

$$(15)\quad h_1 = 277.2\ (1 - \cos\theta_1) = 2.08 \text{ cms.}$$
$$h_2 = 277.2\ (1 - \cos\theta_2) = 1.16 \text{ cms.}$$

$$(16)\quad h_1 = \sqrt{2\ (980)\ (2.08)}$$
$$= 63.85 \text{ cms.}$$
$$= 2.10 \text{ ft.}$$

$$h_2 = \sqrt{2\ (980)\ (1.16)}$$
$$= 47.68 \text{ cms.}$$
$$= 1.56 \text{ ft.}$$

The velocities of free recoil of the gun alone would therefore have been by equation (18)

$$V_1 = \frac{\left(\frac{36.44}{32.2}\right)\ (2.10)}{\left(\frac{8.81}{32.2}\right)} = 8.69 \text{ ft./sec.}$$

$$V_2 = \frac{\left(\frac{36.44}{32.2}\right)\ (1.56)}{\left(\frac{8.81}{32.2}\right)} = 6.45 \text{ ft./sec.}$$

The kinetic energy of free recoil in each case would therefore have been

$$\text{K. E.}_1 = 1/2\left(\frac{8.81}{32.2}\right)(8.69)^2 = 10.33 \text{ ft. lbs.}$$

$$\text{K. E.}_2 = 1/2\left(\frac{8.81}{32.2}\right)(6.45)^2 = 5.69 \text{ ft. lbs.}$$

Hence "R" the percentage reduction in kinetic energy is

$$R = \frac{10.33 - 5.69}{10.33} = 45 \text{ per cent.}$$

Inasmuch as we now have the value of $M_b V_b$ in (17) we can determine the value of the fictitious quantity "u" which we have called the average gas velocity. We have

$$M_b = \frac{36.44}{32.2};\ V_b = 2.10;\ \text{hence by (17)}$$

$$(2.10)\ \frac{36.44}{32.2} = mv + nu = 2.38$$

where m=150 grains=6.65×10^{-4} gravitational units of mass
n=50 grains=2.22×10^{-4} gravitational units of mass
v=2650 ft./sec.

$$\therefore\ u = \frac{2.38 - (6.65\times10^{-4})\ (2.65\times10^{3})}{2.22\times10^{-4}}$$

$$= 2.793\times10^{3} \text{ or } 2790 \text{ ft./sec. approximately.}$$

Since this is very nearly equal to the muzzle velocity v for the cartridges used in this experiment, the value of the constant "C" in equation (1) may be taken as unity for all practical purposes.

The maximum reduction in the kinetic energy of free recoil theoretically possible for the cartridge used may now be computed from equation (6)

If C = 1 so that u = v. (6) reduces to

$$R = \frac{(m+n)^2 - (m-n)^2}{(m+n)^2} = \frac{(150+50)^2 - (150-50)^2}{(150+50)^2} = \frac{3}{4}$$

We have just shown that the maximum reduction in the kinetic energy of free recoil theoretically possible with the cartridges used in these experiments was 75 per cent. Therefore the caliber .30 Springfield, which showed a reduction of 48 per cent. must have been 64 per cent. efficient and the compensator for the caliber .30 Thompson auto-loading rifle with a reduction of 51 per cent. must have been 68 per cent. efficient.

Apparatus for Climb Adjustment

In the early work of developing a device for the caliber .30 light Browning the piece was placed in a frame with the butt backed against a rubber cushion (Fig. 5). The muzzle was suspended by a long, elastic cord "A" so that it was normally level but if displaced slightly would oscillate up and down. An aluminum rod "B" connected the muzzle "C" with a light aluminum sheet "D" running in guides "E." Light from the arc lamp "F" passed through the diagonal slot in the sheet "D" and into the camera at the point where the shutter slot "G" intersected that in the sheet "D." It may be seen that as the muzzle and therefore the sheet "D" moved up and down the intersection of the two slots referred to moved back and forth. The camera drum "H" takes a film 8 inches wide and 5 feet long and with this apparatus together with the oscillograph "I" the various stages in the functioning of the piece could be correlated with the motion of the muzzle. A special oscillator provided timing lines on the film one thousandth of a second apart in time. The camera is entirely automatic and operated by the telegraph key seen at "J." The firing lanyard "K" was so adjusted that no turning moment was communicated to the piece in firing either single shots or bursts.

With this apparatus an adjustment of the compensator may readily be obtained in which the piece will fire full automatic, with the compensator attached, without moving either up or down to any great extent. Such an adjustment is of little use, however, for service conditions, since when the piece is backed as it was here the moment arm is very short, perhaps half a foot, being equal to the perpendicular from the point of support to the axis of the bore produced; but when firing from a standing position the moment arm is increased to the shoulder height of a man, say 5 feet, and the piece climbs rapidly with full automatic fire.

As measured with this apparatus the compensator must be adjusted for a positive downward motion of the muzzle if the piece is to be used for automatic fire from the shoulder.

The training regulations at present do not prescribe automatic fire with the light Browning, as this is con-

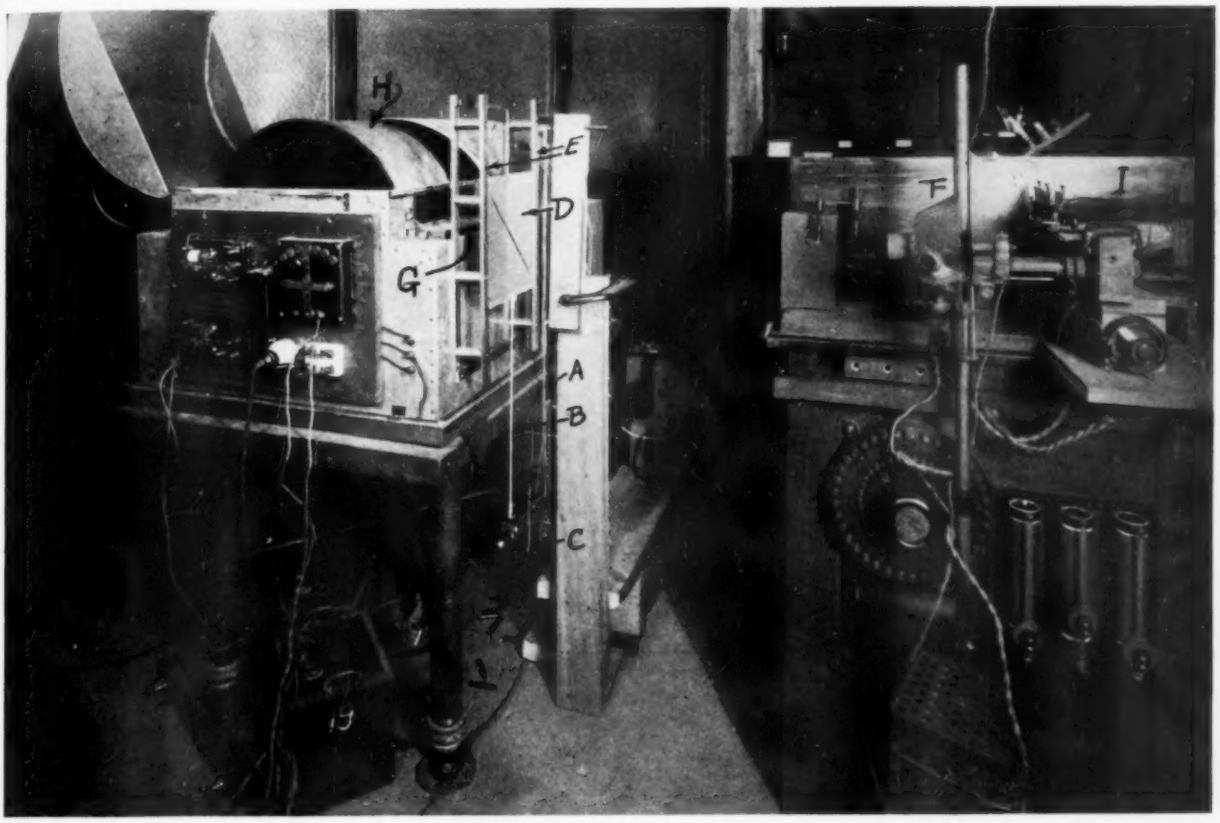


Fig. 5. Apparatus for Climb Adjustment.

sidered to be a waste of ammunition. Targets are sometimes provided to convince the soldier that his semi-automatic scores will greatly excel those fired full automatic.

An inexperienced man firing the light Browning full automatic from the shoulder will probably be unable to keep more than one or two shots on the target even at the shortest range. A sufficiently heavy man may, of course, with practice learn to "ride" the piece, as the saying goes, and make some sort of a full automatic score.

With the compensator as finally developed for this arm full automatic fire becomes entirely feasible, even for a light man, and a concentration of fire may be maintained which heretofore has been quite impossible due to the recoil and climb of the piece.

Effect of the Compensator on Muzzle Velocity and Accuracy

The question is occasionally raised as to the effect of the compensator on muzzle velocity and accuracy. In order to determine the effect on velocity the following oscillograph velocity determinations were made, using the same rifle and firing with and without the device.

Caliber .30 Springfield

Shot	Velocity **Without** Compensator	Shot	Velocity **With** Compensator
1	2775 ft./sec.	7	2775 ft./sec.
2	2740	8	2740
3	2775	9	2775
4	2755	10	2795
5	2705	11	2760
6	2755	12	2740
Mean	2751 ft./sec.	Mean	2764 ft./sec.

Note: The 5th shot is not an error in measurement or computing; the phenomenon is real.

If the low value of shot 5 is omitted, the mean is 2760 and still falls below the 2764 ft./sec. obtained with the compensator attached. However, in view of the comparatively small number of shots fired together with the probable error of the results we should not be justified in claiming that an increased muzzle velocity is obtained when the device is employed. The measurements do, however, establish that within the limits of accuracy of the experiment and therefore well within the limits of practical importance there is no reduction in velocity due to the compensator.

For the accuracy test the same rifle was fired on the 1000 yard range at Quantico, Va., in the fall of 1926 and after two or three sighting shots ten consecutive bull's eyes were registered. The effect on accuracy is therefore not detrimental and it may well be an advantage in that a mass at the muzzle materially reduces muzzle vibration.

General Remarks

Range records show that the first two weeks of shooting are spent in becoming accustomed to the heavy pounding normally associated with high power rifles. At the end of this period of two weeks the average man will have become sufficiently accustomed to the heavy recoil to begin target practice in earnest. If rifles are equipped with the compensator this waste of ammunition might be greatly reduced.

In adapting the compensator to automatic shoulder rifles we have first adjusted the device to overcome the tendency to "climb" and the remainder of the gas is used in antirecoil ports. This adjustment greatly reduces the dispersion.

The compensator has been applied to the caliber .30 Browning automatic rifle, the caliber .30 Springfield, caliber .45 Thompson sub-machine gun used at the present

time by the Marine mail guard, the caliber .30 Browning machine gun and one or two other pieces. The compensator may also prove to be useful for reducing the recoil of certain types of naval and field ordnance. In the case of naval guns the distance through which the piece recoils would be shortened and the deck reinforcing could be considerably lightened. If the throttling bars and similar recoil mechanism were then redesigned it is reasonable to suppose that the total recoil distance might be reduced to 1/2 in the most favorable cases, although a reduction of 1/3, say, would, we believe, be very acceptable.

In the case of antiaircraft guns the service of the piece could be greatly facilitated by a shorter recoil thus making it possible to lower the gun and mount.

With army field guns, where the pieces must often be emplaced under very unfavorable conditions, it might be feasible to weaken the recoil mechanism and absorb say 1/2 of the original energy over the original distance of recoil which would help to keep the piece on its aiming point. The weight of the recoil mechanism, carriages, etc., all could be considerably lightened and the general wear and tear incident to field service reduced proportionately.

Summary

The compensator may be applied to both small arms, machine guns and ordnance and when so applied will neutralize the climb and greatly reduce the kinetic energy of recoil. In the case of the caliber .30 Springfield this reduction, the average of two independent determinations, was 46½ per cent. A reduction of 50 per cent. in the kinetic energy of recoil is usually underestimated and is not perceived by the rifleman as only half the shock. However, such a reduction means that most of the real punishment has been eliminated.

It seems reasonable to suppose that the compensator may be advantageously applied to certain types of ordnance and such work is now under way.

Ammunition—The Great Defense Problem

"YOU read in the Sunday supplements of the single drop of gas which will annihilate a great city; or of a new death ray which will wipe out its defenders with one short shot. We see pictures of skylines of our great cities shimmying and tumbling in ruins as the result of some new and destructive agency of war.

"Many new weapons have been heralded as so terrible that they would bring all wars to an end. As soon as they have become practicable, they have always been promptly met with an equally efficient defense. Gunpowder, heavy ordnance, submarines, planes and gas were all to make war so grim and ghastly that war could not continue. Yet, if anything, the proportion of battle casualties to men engaged has diminished rather than increased. Nine years after the great war, the conflicts now in progress about us bear a great resemblance to all their predecessors.

"I may be reactionary, but I cannot help but believe that no matter how thoroughly an enemy strong point has been bombed or shelled or gassed, the only way it can be taken is by a man who arrives there on his two legs with a rifle in his hand and with ammunition to make that rifle effective.

"Ammunition is the great problem which faces those of us charged with the responsibility for the national protection. Following the mandates of the Defense Act, the law of the land, we report to you annually our progress in the Industrial Preparedness plans, which a war-experienced Congress imposed upon us. The most painstaking advance planning will not bring us quantity production of small arms ammunition in less than a year. What we have on hand is 10 years old, almost as dangerous to the shooter as to the shootee. What is more, the amount we have on hand would last but a few weeks. Without it, all branches of the service would be helpless in action.

"Industrial Preparedness was not designed to fill the gaps created by an unbalanced, unequipped peace-time establishment. It is a structure built to support the war effort of the nation—once emergency is upon us. It provides a plan whereby all America can go to work on a swift and intelligent program when disaster befalls. It means that the loss of the months and months and millions and millions of 1917 and 1918 shall not be repeated.

"Ever since the war the army has been living off its fat supplies which we piled up on wharves but never dispatched overseas. The army has contributed its full share toward the reduction of the war debt by sale of this property and return to the Treasury of the proceeds. This disposal has comprised commercial articles, easily and quickly replaceable.

"The war taught us some bitter lessons. We have profited by most of them. Around the nucleus of a small but expert regular establishment, we have evolved plans for an army of the United States. We are training men to assume its leadership through the Reserve Corps, the Reserve Officers' Training Corps and the Citizens' Military Training Camps. We have federalized and energized the State troops of the Guard. We have initiated a forward-looking program for our defense in the air. Many elements have been held back and perhaps not properly developed, but in only one regard have we actually fallen down. We have not kept up our war reserves. Age and lack of replacement will soon completely wipe out small stores of ammunition.

"Until there are funds and a disposition to set up and maintain sufficient reserves, our plans for manpower and for industrial mobilization are both ineffective. Men cannot stop invasion with ther bodies, long enough to allow industry to meet the demands for their supply. Nor should we ask them to do so." (*From a recent address at Rochester, N. Y., by Hanford MacNider, Assistant Secretary of War.*)

Army Ordnance Association Trophy

First Cavalry Division Horseshow

1926

THE First Cavalry Division Horseshow held at Fort Bliss, Texas, in the closing days of 1926 was something more than a display of good horseflesh. It is on such occasions that our one and only Cavalry Division, which garrisons one thousand miles of our Southwestern international boundary, brings together at Fort Bliss the pick of its horses, mules, vehicles, ordnance equipment, signal equipment and trained personnel, including officers, ladies, soldiers and children, and for two weeks puts on a continuous performance of polo, jumping, cross-country riding, musical drills, displays of equipment and, last but not least, dinners, dances, teas and every kind of social stunt possible to provide a well balanced period of festivity.

WITH such a background it was peculiarly fitting that the excellence of care and maintenance of ordnance issued to the organizations of the Division should be rewarded by a suitable individual trophy and the Army Ordnance Association embraced the opportunity and provided a pearl handled "Officers Model .38 Colt Revolver" and holster suitably marked with an engraved silver plate.

THE Horseshow Committee arranged a "Best Ordnance Equipment" Class in which the entries were to be ten in number as follows:

(1) The winner of a previous class for artillery sections;

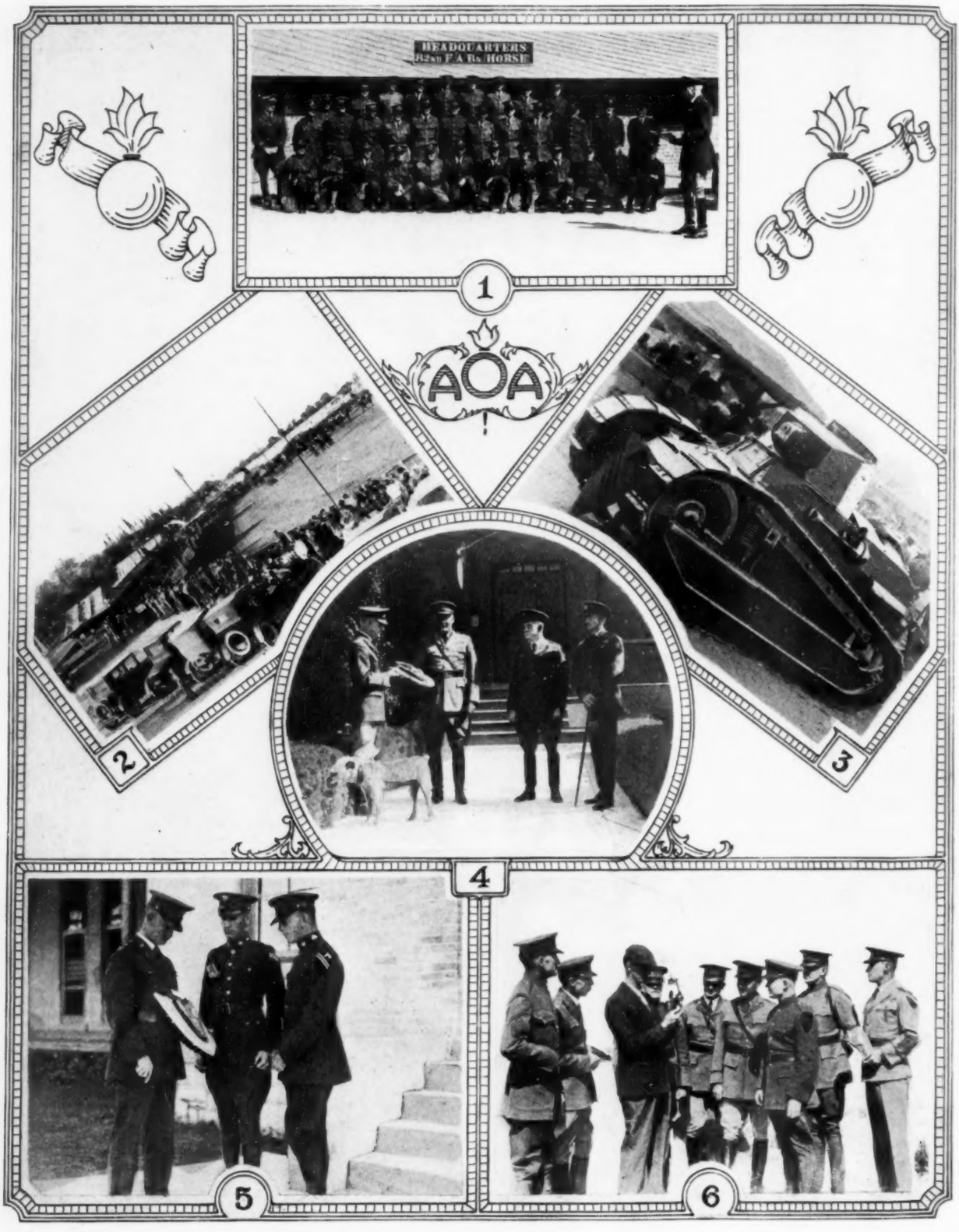
(2) The winner of a previous class for machine gun squads;

(3) Four entries, one from each of the four Cavalry regiments in the Division, showing machine rifle and packs;

(4) Four group entries, one from each Cavalry regiment, each showing the ordnance equipment of a cavalry trooper, rifle, pistol and saber.

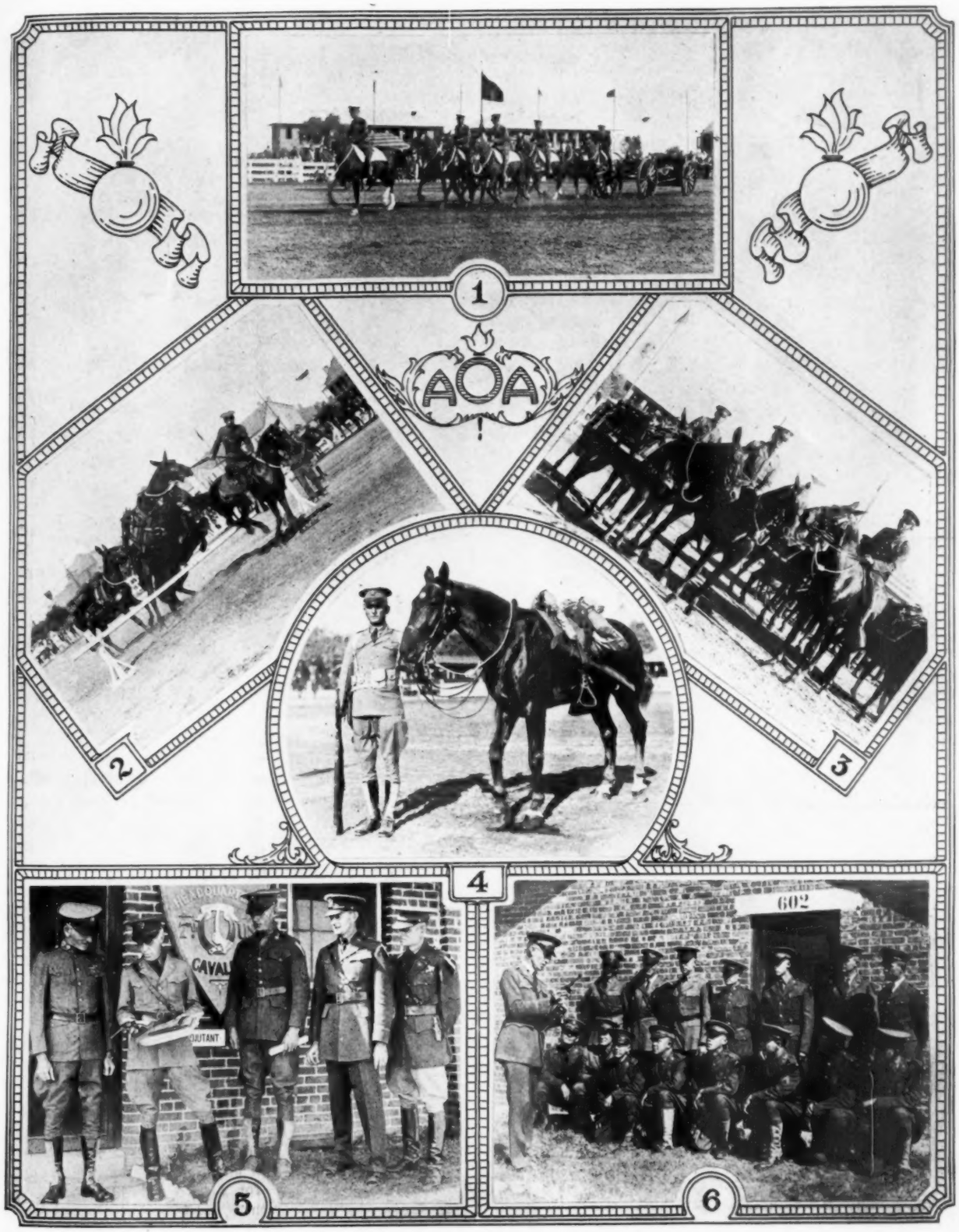
THE interest in the trophy was far beyond expectations and competition was unusually keen. Cavalry regiments held preliminary tryouts and when the class was called on the last day of the show the assembly of well-groomed ordnance was good to look upon.

ALL three of the Ordnance officers on duty in the First Cavalry Division at Fort Bliss worked desperately hard for the hour allowed in making a detailed inspection of the ordnance of the entries and unanimously voted Pvt. 1st Class John Saneski, Troop A, 7th U. S. Cavalry, the Rifle-Pistol-Sabre entry from that famous regiment, the winner.



Army Ordnance Association Trophy Excites Keen Competition at Fort Bliss

1. Maj. A. L. P. Sands, 82nd Field Artillery explains merits of A. O. A. Trophy to contestants from his battalion. 2. General view of Stadium, Fort Bliss, where contest was held. 3. Tank exhibited by the 27th Ordnance Company. 4. 1st Lieut. J. G. Sucher, Asst. Post Ordnance Officer, Fort Bliss, on behalf of the Army Ordnance Association, presents the A. O. A. trophy to Brig. Gen. E. B. Winans, U. S. A., Comdg. 1st Cavalry Division, who accepts it for the Horse Show Committee. 5. Col. S. McP. Rutherford. 8th U. S. Cavalry, gives the entries from his regiment a close-up view of the A. O. A. Trophy. 6. Mechanic Whelan, Fort Bliss Civilian Small Arms Expert, says the Trophy is mechanically O. K. after firing.



COMPETITORS FOR ARMY ORDNANCE ASSOCIATION TROPHY, FIRST CAVALRY DIVISION HORSE SHOW

1. The 82nd Field Artillery Battalion (Horse) Entry. 2. The Machine Gun entry goes up and over. 3. The Second Machine Gun Squadron entry. 4. The Rifle, Pistol, Sabre Group entry from 7th U. S. Cavalry, winner of the A. O. A. Trophy: Private 1st Class John Saneski, Troop A, 7th U. S. Cavalry. Expert Rifleman since 1918, Pistol Expert since 1921, Member Cavalry Rifle Team, 1923. 5. Col. Fitzhugh Lee, 7th U. S. Cavalry and his Staff showing the A. O. A. Trophy to 7th Cavalry entries. 7. Maj. J. B. Johnson, 2nd Machine Gun Squadron, explaining the fine points of A. O. A. Trophy to potential winners of his squadron.

Ordnance Budget and Fiscal System

Part II.

Maj. C. T. Harris, Jr., Ord. Dept. U. S. A.

BEFORE passing on to the subject of appropriations it might be appropriate to state that the Ordnance Department, including its arsenals, depots, proving ground, etc., is a very much larger machine than is required for peace-time operation and that operating this huge Ordnance machine in time of peace cannot be economically done. It is a good deal like pulling a baby carriage with a 5-ton tractor. To turn over the wheels of this machine, to keep it from stopping absolutely, and to take care of the Ordnance material which is in being and which we are charged with maintaining, and to maintain our Ordnance activities in the Procurement Districts and in the Corps Areas, together with the operation of the Ordnance Office in Washington, costs each year in the neighborhood of $9,000,000. In other words, we must get about $9,000,000 each year to keep the Ordnance machine turning over.

It may be of interest to know that in the fiscal year 1925 the Ordnance establishments expended the following amounts:

Aberdeen Proving Ground	$ 766,184
Frankford Arsenal	1,041,511
Picatinny Arsenal	1,008,470
Rock Island Arsenal	984,422

(Here is an interesting point. Rock Island Arsenal, the biggest arsenal before the war, has been outstripped by the Frankford Arsenal and by the youngest manufacturing arsenal of them all—Picatinny Arsenal. The reasons for that are obvious. Frankford Arsenal and Picatinny Arsenal have most to do with ammunition. Ammunition is at last coming into its own.)

Watertown Arsenal	$ 751,090
Springfield Armory	448,525
Watervliet Arsenal	258,763
Nitrate Plants	86,751
Raritan Arsenal	431,188
Benicia Arsenal	150,602
Augusta Arsenal	72,946
San Antonio Arsenal	119,928
Charleston Depot	59,766
Curtis Bay Ordnance Reserve Depot	77,443
Delaware Ordnance Reserve Depot	50,844
Erie Ordnance Reserve Depot	103,632
Savanna Ordnance Reserve Depot	88,389
Pig Point Ordnance Reserve Depot	68,165
Ogden Arsenal	6,270
Panama Canal Ordnance Depot	86,584
Hawaiian Ordnance Depot	96,000
Philippine Island Ordnance Depot	87,247
Miscellaneous, including Ordnance Office, District Offices and Corps Areas	1,009,628

In order to show the place in the War Department sun occupied by the Ordnance Department over a number of years, the following chart is included. This shows for each fiscal year the amount of money appropriated for the Ordnance Department contrasted with the total amount of money appropriated for the military activities of the War Department, and shows the percentage of the Ordnance Department's share of the whole. The interesting feature of the table is that in the years 1910 to 1914 we were receiving more than 8 per cent. of the total military appropriations, while at the present time, from 1923 to date, we have been receiving a little less than 3 per cent. Let us hope that in the future we may again grow to the former figure. If we now had that percentage of the total appropriation, problems such as maintaining the war reserve in first-class condition would be easily solved.

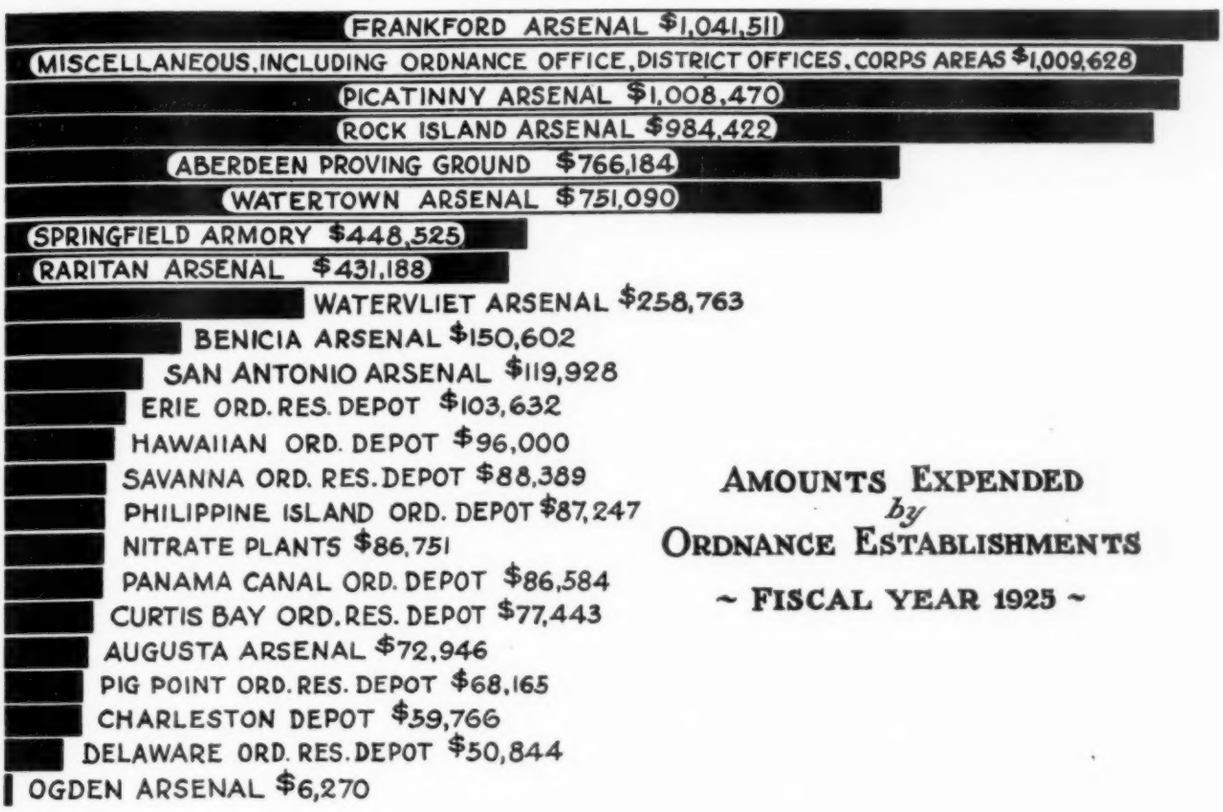
Total Appropriations for the Ordnance Department Compared With Total Appropriations for the Military Activities of the War Department for the Fiscal Years 1910 to 1927, Inclusive.

Fiscal Year.	Ordnance Department.	War Department.	Percentage.
1910	$ 10,093,856.00	$ 115,696,518.61	8.72
1911	9,210,554.60	109,971,367.17	8.37
1912	8,794,475.00	104,845,810.52	8.38
1913	9,001,733.30	115,561,920.10	7.78
1914	9,503,641.00	112,859,212.59	8.42
1915	12,353,432.00	125,514,560.95	9.84
1916	14,947,110.00	113,505,383.29	13.10
1917	324,629,574.50	2,810,397,141.76	11.50
1918	3,103,599,681.86	5,667,358,136.29	54.70
1919	4,199,903,211.67	16,316,503,199.32	25.70
1920	20,805,634.79	813,304,262.20	2.55
1921	22,880,186.06	495,122,339.55	4.62
1922	13,425,960.00	373,019,831.22	3.59
1923	6,859,030.00	270,184,805.19	2.52
1924	5,812,180.00	256,669,118.00	2.26
1925	7,751,272.00	260,246,731.67	2.97
1926	7,543,802.00	260,757,250.00	2.89
1927 (Est.)	9,482,327.00	261,116,650.00	3.63

II. APPROPRIATIONS

Assuming that Congress has made money available, it may be of interest to know under what appropriation items the funds are provided, for what purposes the funds can be used, and how long these funds are available for use. To start with, attention is invited to the fact that appropriations are of three kinds: annual, biennial and permanent.

"Annual and biennial appropriations are available for obligations made in the Office of the Chief of Ordnance during the fiscal year, or years, for which appropriated and for disbursement two years after they expire for such obligations, as for example, the appropriation 'Field


FRANKFORD ARSENAL $1,041,511
MISCELLANEOUS, INCLUDING ORDNANCE OFFICE, DISTRICT OFFICES, CORPS AREAS $1,009,628
PICATINNY ARSENAL $1,008,470
ROCK ISLAND ARSENAL $984,422
ABERDEEN PROVING GROUND $766,184
WATERTOWN ARSENAL $751,090
SPRINGFIELD ARMORY $448,525
RARITAN ARSENAL $431,188
WATERVLIET ARSENAL $258,763
BENICIA ARSENAL $150,602
SAN ANTONIO ARSENAL $119,928
ERIE ORD. RES. DEPOT $103,632
HAWAIIAN ORD. DEPOT $96,000
SAVANNA ORD. RES. DEPOT $88,389
PHILIPPINE ISLAND ORD. DEPOT $87,247
NITRATE PLANTS $86,751
PANAMA CANAL ORD. DEPOT $86,584
CURTIS BAY ORD. RES. DEPOT $77,443
AUGUSTA ARSENAL $72,946
PIG POINT ORD. RES. DEPOT $68,165
CHARLESTON DEPOT $59,766
DELAWARE ORD. RES. DEPOT $50,844
OGDEN ARSENAL $6,270

AMOUNTS EXPENDED
by
ORDNANCE ESTABLISHMENTS
~ FISCAL YEAR 1925 ~

Artillery Armament, 1925, "B"," an annual appropriation, is available for current obligations during the period July 1, 1924, to June 30, 1925, inclusive, and for expenditures on such obligations two years thereafter. The appropriation 'Ordnance Stores—Ammunition, 1925 and 1926,' a biennial appropriation, is available for obligations for the period July 1, 1924, to June 30, 1926, inclusive, and for disbursements on such obligations two years thereafter, at which time all unexpended balances revert to the Treasury. Permanent appropriations are available for disbursement until expended. The titles and objects of the appropriations of the Ordnance Department are published annually in Ordnance Office general orders soon after the approval of the appropriation bills. The title of an annual or biennial appropriation is always followed by the designation of the year, or years, for which the appropriation is made; the title of permanent appropriation is not followed by the designation of any year.

"As all unexpended balances of annual and biennial appropriations are required by law to be covered into the surplus fund of the Treasury at the expiration of two years after the close of the fiscal year, or years, for which made, no disbursements can be made from the appropriations after that date.

"The Army Act of June 5, 1920, which reads, in part, as follows:

'That all orders or contracts for the manufacture of material pertaining to approved projects heretofore or hereafter placed with Government-owned establishments shall be considered as obligations in the same manner as provided for similar orders placed with commercial manufacturers, and the appropriations shall remain available for the payment of the obligations so created as in the case of contracts or orders with commercial manufacturers,'

provides that government establishments may place orders for material against such approved projects as may be necessary for their completion during the full life of the appropriation, and also make payments, during the same period, for the necessary labor in connection with the approved project; provided payment can be made prior to the time the funds revert to the Treasury Department by limitation. This provision of law was requested at the time permanent appropriations were discontinued, in order to enable the Ordnance establishments to complete orders for manufacture, or for definitely defined experimental work, during the life of annual and biennial appropriations. With appropriations for current expenses, such as 'Ordnance Service' and 'Repairs of Arsenals,' it has not been the policy of the Department to issue approved projects, except in some special cases, or for current work which should be completed within the current fiscal year." ("The Ordnance Financial Cycle," by Maj. C. E. McRae, Ord. Res., ARMY ORDNANCE, Vol. IV, No. 22.)

Regular Ordnance Appropriations

I shall briefly describe the various Ordnance appropriation items:

Ordnance Service: A general operating appropriation which pays the expenses of many things: receiving and issuing ordnance and ordnance stores, property accountability, watchmen services, rents, tolls, fuel, light, water, advertising, incidental expenses, etc. Every Ordnance establishment gets some part of this appropriation. This is a one-year appropriation. Estimated amount for the fiscal year 1927, $1,066,500.

Ordnance Stores—Ammunition: This is a two-year appropriation which covers development, manufacture and maintenance of airplane bombs, pyrotechnics, grenades, small arms ammunition, targets, accessories, etc. This appropriation to a large extent supports Frankford Arsenal, and to a lesser extent Picatinny Arsenal. Watertown and Rock Island Arsenals get a smaller share. Estimated amount for the fiscal years 1927 and 1928, $2,801,135. Here appears the first provision for ammunition reserve turnover.

Manufacture of Arms: A two-year appropriation, for manufacture, repairing, procuring and issuing arms at the national armories. Most of this appropriation goes to Springfield Armory, although several of the depots get a small amount in connection with maintaining and issuing small arms. Estimated amount for the fiscal years 1927 and 1928, $300,000.

Ordnance Stores and Supplies: A two-year appropriation for overhauling, cleaning, repairing and preserving ordnance and ordnance stores. There has recently come back to the Ordnance Department the responsibility for cleaning and preserving materials for the Army. We had it before the war, the Quartermaster took it over, and now it has come back to us. The Quartermaster still acts as purchasing agent to a large extent in the expenditure of this appropriation, although now the Ordnance Department writes the specifications. Estimated amount for the fiscal years 1927 and 1928, $595,000.

Automatic Rifles: A two-year appropriation for purchase, manufacture, test and repair of automatic rifles and accessories. A large part of this goes to Springfield Armory, although a considerable amount is spent each year with commercial concerns, such as the Colt Patent Fire Arms Company. A big part of this appropriation goes to securing automatic rifles for planes in the Air Corps. Estimated amount for the fiscal years 1927 and 1928, $363,000.

Tanks: A two-year appropriation for the purchase, manufacture, test and maintenance and repair of tanks and other self-propelled armored vehicles. A portion of this is spent at Rock Island, a portion at Camp Meade and a portion at Field Service depots. Estimated amount for the fiscal years 1927 and 1928, $264,000.

Field Artillery Armament, "B": A one-year appropriation for the purchase, manufacture, and test of mountain, field and siege cannon, including accessories. A very large per cent. of this is spent at the Rock Island Arsenal, a smaller amount at the Watervliet Arsenal and at the Watertown Arsenal. All of our development work for medium sized artillery is paid for out of this appropriation. Estimated amount for the fiscal year 1927, $535,000.

Field Artillery Armament "C": A one-year appropriation for the purchase, manufacture, maintenance and test of ammunition for mountain, field and siege cannon. A major portion of this is spent at the Picatinny Arsenal, although a considerable amount is spent at Field Service depots in maintaining the war reserve ammunition. Estimated amount for the fiscal year 1927, $386,000.

Field Artillery Armament "L": A one-year appropriation for the alteration and maintenance of mobile artillery including accessories. This is purely a Field Service appropriation and is expended in the Corps Areas, in Field Service depots, and in the Field Service Section of certain of the arsenals. Estimated amount for the fiscal year 1927, $550,000.

Field Artillery Armament "N": A one-year appropriation for the purchase, manufacture, and test of ammunition for target practice for field artillery. Most of this is spent at the Picatinny Arsenal, although a certain amount is expended in the purchase of propellents from commercial companies. Estimated amount for the fiscal year 1927, $167,000.

Proving Grounds, Army: A one-year overhead appropriation for the Proving Ground covering current expenses, comprising the maintenance of rail and water transportation, repairs, alterations, accessories, and services of employees incidental to testing and proving ordnance and ordnance material, purchase of instruments and articles required in experimental work, etc. This is all expended at the Aberdeen Proving Ground. Estimated amount for the fiscal year 1927, $171,000.

Rock Island Bridge: A one-year appropriation for operation, repair and preservation of Rock Island bridges and viaduct. The main bridge crosses the Mississippi River at Rock Island. Half of the maintenance charges of this bridge is paid by the Rock Island Railroad, although this is in the nature of a refund, the initial expenditure being by the Government and the amount paid by the Rock Island Railroad going back into the Treasury. Estimated amount for the fiscal year 1927, $30,000.

Testing Machines: This is a one-year appropriation for the operation of testing machines and the laboratory at Watertown Arsenal. Estimated amount for the fiscal year 1927, $20,000.

Repairs of Arsenals: This is a one-year appropriation for the repair and improvement of arsenals and depots and to meet such unforeseen expenditures as accidents or other contingencies during the year may render necessary. Every establishment gets a part of this appropriation. This is an appropriation which is bound to be increased in the coming years, as the degree of repair of Ordnance facilities at present will not keep them in serviceable condition. Estimated amount for the fiscal year 1927, $607,500. As I am not talking to a Committee in Congress, budget instructions will allow me to express the opinion that this is not half enough.

Gages, Dies and Jigs for Manufacture: A one-year appropriation for design and procurement of gages. Each of the manufacturing arsenals gets a part of this money. The amount appropriated is only a fraction of what is needed. Estimated amount for the fiscal year 1927, $50,000.

Armament of Fortifications, "DFG": A one-year appropriation for purchase, manufacture, and test of seacoast cannon. Practically the only activity now under this appropriation is carrying out the 16-inch gun carriage program. This project is carried forwarded about one unit each year. Practically all the funds are expended at the Watertown Arsenal. Estimated amount for the fiscal year 1927, $357,000.

Armament of Fortifications, "H": A one-year appropriation for the purchase, manufacture and test of ammunition for seacoast and antiaircraft guns. Practically all of these funds are spent at Picatinny Arsenal, Frankford Arsenal and the Aberdeen Proving Ground. Estimated amount for the fiscal year 1927, $150,000.

Armament of Fortifications, "K": A one-year appropriation for the purchase, manufacture, and test of subcaliber guns, ammunition and other accessories for seacoast artillery practice. Most of this is spent at Picatinny Arsenal and with commercial concerns. Estimated amount for the fiscal year 1927, $276,872.

Armament of Fortifications, "M": A one-year appropriation for the alteration and maintenance of seacoast and antiaircraft artillery. This is entirely a Field Service fund and is expended at depots in the Corps Areas and at some of the arsenals by direction of the Field Service. Estimated amount for the fiscal year 1927, $200,000.

I might mention that here we have suffered a cut of $100,000 from the amount appropriated for the last number of years. Cuts had to be made somewhere to start the turnover of the war reserves of ammunition and this is one of them. In subsequent years the former figure must be requested.

Armament of Fortifications, Insular Possessions, "H": A one-year appropriation for the procurement of ammunition for seacoast and antiaircraft artillery in Hawaii and the Philippines. Most of this is spent at Picatinny Arsenal. Estimated amount for the fiscal year 1927, $158,100.

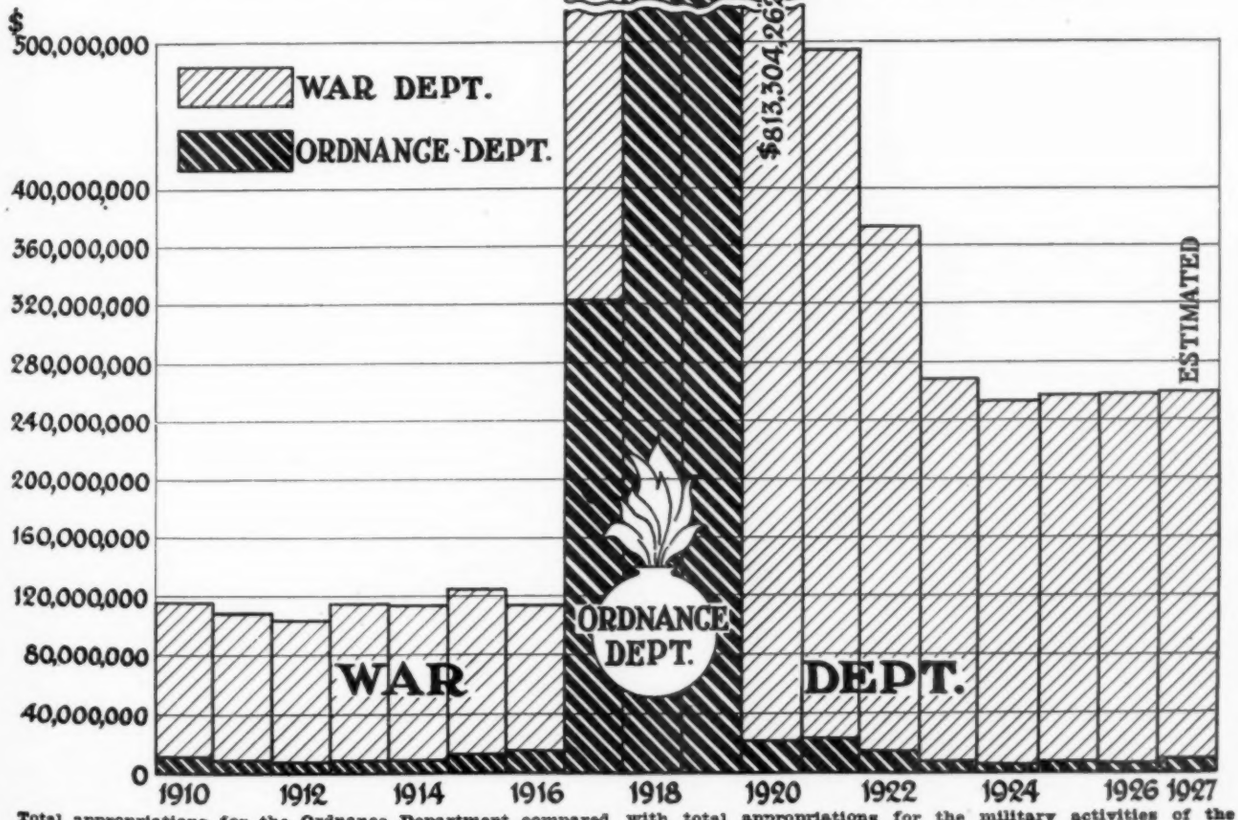
Armament of Fortifications, Insular Possessions, "M": A one-year appropriation for maintenance of seacoast and antiaircraft artillery in Hawaii and the Philippines. This is all spent by the Field Service agencies. Estimated amount for the fiscal year 1927, $75,000.

Armament of Fortifications, Panama Canal, "DFG": A one-year appropriation for the purchase, manufacture and test of seacoast and antiaircraft artillery for the Canal Zone. This is expended mostly at Watertown Arsenal. Estimated amount for the fiscal year 1927, $55,100.

Armament of Fortifications, Panama Canal, "H": A one-year appropriation for the procurement of seacoast and antiaircraft ammunition for the Canal Zone. This is mostly expended at Picatinny Arsenal. Estimated amount for the fiscal year 1927, $95,350.

Armament of Fortifications, Panama Canal, "M": A one-year appropriation for the maintenance of seacoast and antiaircraft artillery in the Panama Canal. This is all spent by Field Service agencies. Estimated amount for the fiscal year 1927, $50,000.

Office of Chief of Ordnance: Salaries, on the Statutory Roll, provide for 98 civilian employees in the Office of the Chief of Ordnance. Estimated amount for the fiscal year 1927, $158,770. This is all spent in Washington.



Total appropriations for the Ordnance Department compared with total appropriations for the military activities of the War Department for the fiscal years 1910 to 1927, inclusive.

In addition there is a clause in the Appropriation Act which allows not to exceed $250,000 for 1927 to be expended on what we term the Allotment Roll, for draftsmen and other services necessary in design. The funds are taken in proper proportion from all the appropriation items of the Ordnance Department. One hundred and two people are provided under this, making the total civilian office force in Washington for 1927, 200.

Other Sources of Funds

In addition to the above Ordnance Department appropriation items, which occur in the Appropriation Act, each and every year, there are two appropriation authorizations I desire to mention, the first the authorization entitled "Replacing Ordnance and Ordnance Stores," and the second the authorization entitled "Ordnance Material—Proceeds of Sales."

Replacing Ordnance and Ordnance Stores: All of the appropriations discussed above are, in general, for the Regular Army, although certain activities, of course, are carried on for the benefit of all elements of the Army. The National Guard, Organized Reserves, Reserve Officers' Training Corps, and Citizens' Military Training Camp elements of the Army carry their own appropriations. These elements require ammunition for their training. Under certain conditions, as, for example, when the issue of these articles depletes the authorized war reserve, reimbursement is required to the Ordnance Department for such issues. In addition there are authorized sales of arms and equipment. Under certain conditions issues to the Navy and Marine Corps are also authorized. All of these issues naturally deplete the stocks of Ordnance arms and equipment and in turn in most cases they are paid for under conditions that allow the funds to be used for the replacement of the articles in question, or for procurement of other needed articles. Up to 1904 the funds accruing from transfers and sales were credited to the appropriation from which the materials were procured. This entailed considerable clerical work and was quite unsatisfactory from an accounting standpoint. Therefore Congress in the Act of April 23, 1904, 33 Stat., 276, passed the following legislation:

"Hereafter all moneys arising from disposition authorized by law and regulation of serviceable ordnance and ordnance stores shall constitute one fund on the books of the Treasury Department, which shall be available to replace ordnance and ordnance stores throughout the fiscal year in which disposition was effected and throughout the following year."

The effect of this law has been to create a two-year fund from which the proceeds of sales and transfers of serviceable stores can be used to procure such stores or other stores required. Prior to the World War there was an average of about $2,000,000 received and expended from this fund each year. Since the war there have been quite large receipts, but in the early years after the war, due to the large amount of funds available from other sources, the expenditures from this authorization were relatively small. It may be stated that now, since funds available have become limited, the Replacing Ordnance and Ordnance Stores accretions are being fully utilized, and, in the years to come, due to the increase in the amount of stores for which reimbursement will be required, the amount of moneys accruing in this fund will increase and it will be necessary to exercise very great care in apportioning them for expenditure. I anticipate that, in the very near future, there will be received in this fund each year $3,000,000 or $4,000,000. This amount will be an important percentage of the total amount of funds available to the Ordnance Department.

There is included a table showing the receipts and expenditures under this fund.

Credits and Disbursements Under Replacing Ordnance and Ordnance Stores

Year.	Receipts.	Expenditures.
1912-1913	$ 2,160,998.09	$ 2,160,002.82
1913-1914	1,563,653.79	1,563,482.24
1914-1915	1,888,181.19	1,888,103.28
1915-1916	1,017,508.15	1,017,067.83
1916-1917	544,534.57	540,796.96
1919-1920	1,055,675.21	372,259.53
1920-1921	4,268,333.06	1,617,141.19
1921-1922	3,006,531.64	20,270.56
1922-1923	786,539.95	418,609.69
1923-1924	576,923.18	360,004.53
1924-1925	914,268.19	Est. 900,000.00
1925-1926	1,487,355.24	Est. 1,487,000.00

Ordnance Material—Proceeds of Sales: There are always accumulations of unserviceable ordnance material which from time to time are sold. In the Act of March 3, 1875, entitled "Ordnance Material—Proceeds of Sales," the following legislation was passed:

"That the Secretary of the Navy is authorized to dispose of the useless ordnance material on hand at public sale, according to law, the net proceeds of which shall be turned into the Treasury; and an amount equal to the same is hereby appropriated, to be applied to the purpose of procuring a supply of material adapted in manufacture and calibre to the present wants of the service; but there shall be expended, under this provision, not more than seventy-five thousand dollars in one year; and in the case of sale of like materials in the War Department, the proceeds of which shall be turned into the Treasury, an amount equal to the net proceeds of such sale is hereby appropriated for the purpose of procuring a supply of material adapted in manufacture and calibre to the present wants of the war service; and there shall be expended in the War Department, under this provision, not more than seventy-five thousand dollars in any one year."

It will be noted that, irrespective of the amount of money deposited in the Treasury from the sale of unserviceable ordnance material, only $75,000 is available for expenditure for replacement purposes.

Transfers from Other Departments and Bureaus: Another source of income is from the sale or transfer of Ordnance stores to the Navy or other Departments. This is provided for by legislation. There are two methods authorized—a transfer or sale of existing ordnance, with the funds received therefor going into the fund Replacing Ordnance and Ordnance Stores; or, in case we are to manufacture for the Navy Department, or Marine Corps, or other Government agency, it is possible to transfer the funds in advance for us to use in such manufacture. In

the first case we sell them completed articles; and in the second case we make something for them with funds furnished by them.

In the fiscal year 1925 the Ordnance Department received the following funds by direct transfer from various Departments of the Government for work to be performed:

Air Service	$ 47,500
Chemical Warfare Service	20,000
Coast Artillery	117,600
Finance Department	179,000
Militia Bureau	38,500
Signal Corps	55,500
Navy Department	1,100,600
Interior Department	25,000
	$1,583,700

These funds did not go into Replacing Ordnance and Ordnance Stores, but were transferred direct to us for our use. Not all of these funds were expended at the arsenals, however, as, in the case of a large percentage of the Navy allotment, the expenditures were made direct with the Colt Patent Fire Arms Company for the procurement of machine guns.

Work Required to Be Done at Arsenals

There is certain legislation in the National Defense Act which requires the Assistant Secretary of War to have manufactured at the arsenals and Government factories those materials which can be efficiently and economically produced thereat. There is a unit in the Ordnance Office known as the Arsenal Orders Branch whose duty is to secure from the Government arsenals bids on material required by other bureaus and to submit these bids in competition with outside firms. The wisdom of this legislation is a mooted point, however, as the more work put into the arsenals the less work naturally goes to commercial concerns; and the existence of commercial concerns capable of making munitions of war is in the minds of many a better preparedness step than keeping the arsenals going at a little greater capacity.

III. EXPENDING AND ACCOUNTING

As stated previously, the Budget and Accounting Act approved in 1921 brought into being a second very important Government official, the Comptroller General of the United States, an official who in general is answerable only to Congress and is independent of Executive control. He is given full authority to make such rules and regulations considered by him to be necessary for a proper accounting of the expenditure of Government funds.

The National Defense Act of 1920 created the office of the Chief of Finance, who is charged by law with the disbursement of the funds for the War Department, and such other fiscal and accounting duties as may be required by law or assigned to him by the Secretary of War; he is the Requisition Officer of the Secretary of War.

Apportionment and Allotment Procedure

"Under the provisions of Section 3679 R. S., as amended by the Act of Congress approved February 27, 1906 (34 Stat., 48 and 49), the various annual and biennial appropriations made for the services of the Ordnance Department are, on or before the beginning of each fiscal year, apportioned by the Secretary of War, so as to prevent undue expenditures in one portion of the year that might result in deficiency or additional appropriations for the remainder of the year. This apportionment constitutes the first grand division of the appropriations concerned and simply limits under the several appropriations the amounts which may be expended during a designated period, this apportionment, at the present time, being by quarters of the fiscal year. Unless otherwise stated, appropriations are made to cover a fiscal year (which begins July 1 and ends June 30) subdivided as follows:

First Quarter—July 1 to September 30,
Second Quarter—October 1 to December 31,
Third Quarter—January 1 to March 31,
Fourth Quarter—April 1 to June 30.

"Based upon these apportionments, the Fiscal Officer, who has general charge of the apportionment and subapportionment of funds in the Ordnance Office, makes further subdivisions, assigning to each of the several Divisions of the Office the amounts which will be applied to the duties of that Division. After the subapportionments are made to the Divisions of the Office the actual distribution of funds, in order to carry out the purposes for which the appropriations were made, is affected by the process of allotting for each specific object a definite amount on the books of the Ordnance Office in the Finance Contact Section. These allotments are then routed to the Office of the Chief of Finance for proper record. The Finance Contact Section, besides keeping a record of allotments and apportionments, acts as liaison on all finance matters with the Chief of Finance, the several Bureaus of the War Department, and other government agencies. Allotments are issued to the various agencies as, what are called, 'Procurement Authorities'. When a commanding officer at an Ordnance station has been notified of an allotment of funds for any purpose he is authorized to make such disposition, and to incur such indebtedness in the amount allotted and in accordance with existing orders, as may be necessary for carrying out the object for which the allotment was made. Records are kept at Ordnance stations of all transactions under allotments, stock fund, and shop expense accounts on forms prepared for this purpose. An obligation must not be incurred where there is no allotment to authorize it, or when the allotment does not properly authorize it. An appropriation is properly charged with all expenditures necessary to accomplish the object for which it was made, unless particular items of expense are specifically provided for in some other appropriation (IV Comp. Dec. 24). Therefore when a specific appropriation is made to cover particular expenditures such expenditures cannot be charged to a general appropriation which might otherwise be applicable. Whenever an allotment is found to be insufficient, timely report is made in order that an additional allotment may be made, or that the work to be done may be modified. Should the allotment be in excess of that required for the work, the surplus is reported to the Ordnance Office for revocation. Unless specifically authorized, no advance of public money may be made prior to the receipt of supplies or services for which payment is made, with certain exceptions to this general rule, viz.,

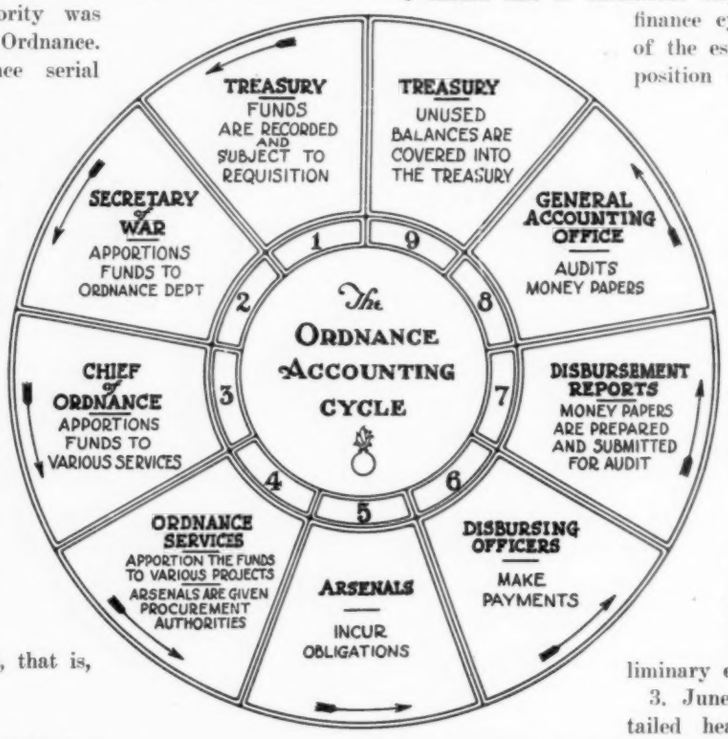
the payment of subscriptions to newspapers, periodicals and other publications purchased from public funds for official use, which may be paid in advance from appropriations available at the time of making subscriptions." ("The Ordnance Financial Cycle," by Maj. C. E. McRae, Ord. Res., Army Ordnance, Vol. II, No. 22.)

Procurement Authorities

In connection with the issue of procurement authorities identification marks are necessary for code purposes, as well as for identification purposes. Below is a complete procurement authority number.

ORD 3405 P 1485 A 2240-67

This group of letters and figures represent a complete Procurement Authority reference. "ORD" indicates that the procurement authority was issued by the Chief of Ordnance. "3405" is the Ordnance serial number of the procurement authority. "P 1485" indicates the purpose number, and shows that this procurement authority was issued for the procurement of "Rifles, side arms, swords, sabers, small arms, accoutrements, accessories and parts." "A 2240" indicates the appropriation "Manufacture of Arms." The letters "P" and "A" are used primarily to separate the groups of figures. "67" indicates the fiscal years for which the appropriation was made, that is, 1926 and 1927.



The Code System

There are two code systems used. The General Accounting Office code, Bulletin No. 1, May 11, 1922, which carries out the provisions of Section 309 of the Budget and Accounting Act approved June 10, 1921, is used by the Director of the Bureau of the Budget to show the classification of objects of expenditure for the various Departments and establishments of the Government. This code is divided into 52 main group headings, as, for example:

01 Personal Services
02 Supplies and materials
05 Communication service
06 Travel expenses
07 Transportation of things
12 Repairs and alterations

This code is only used by the War Department in submitting its annual appropriation estimates to the Director of the Bureau of the Budget.

The other code, which is called the War Department code, and is authorized in General Orders No. 10, War Department, 1925, and Finance Circular No. 7, War Department, 1925, was prepared by a special committee to more fully meet the requirements of the Finance Department in compiling data for the Secretary of War, Bureau of the Budget, and Congress. This code breaks down the main headings in the General Accounting Office code in greater detail and under purposes more applicable to War Department expenditures, and at the same time provides a complete code reference to be placed on all disbursing papers, which describes the Bureau of the War Department, the serial number of the procurement authority, the purpose, and the appropriation.

The Finance Cycle

I should like to enumerate step by step the complete finance cycle from the inception of the estimates to the final disposition of the budget accounts by the Comptroller General and the return of any unexpended balances to the Treasury.

I will assume that the funds in question are for the fiscal year 1928:

1. January, 1926, to approximately April, 1926: discussion and formulation of War Department Budget directive.

2. April and May, 1926: formulation and submission to the Budget Officer of the War Department of the Ordnance Department preliminary estimates.

3. June and July, 1926: detailed hearings and discussions before the Budget Advisory Committee of the Budget Officer of the War Department.

4. August, 1926: consideration and determination by the War Council of the War Department estimates.

5. Latter part of August, 1926, and first part of September, 1926: preparation of final estimates for submission to the Director of the Bureau of the Budget.

6. September 15, 1926: submission by the Secretary of War of the War Department budget to the Director of the Bureau of the Budget.

7. Latter part of September and early part of October, 1926: consideration and investigation of estimates by the office of the Director of the Bureau of the Budget.

8. November, 1926: hearings by the Director of the Bureau of the Budget at which the Chief of Ordnance presents the Ordnance estimates.

9. December, 1926: transmission by the President to the Congress of the Government budget.

10. December, 1926, to March, 1927: hearings before the Committees of Congress on the estimates.

11. Prior to June 30, 1927: passage by Congress of the Appropriation Bill.

12. July 1, 1927: funds for the fiscal year 1928 available.

13. June 30, 1928: one-year funds expire for obligation.*

14. June 30, 1929: two-year funds expire for obligation.*

15. June 30, 1930: obligated one-year funds expire for expenditures.

16. June 30, 1931: obligated two-year funds expire for expenditures.

17. All expired unexpended balances returned to the Treasury.

*NOTE: If orders have been placed with the arsenals, in compliance with the Army Act of June 5, 1920, before the expiration of the funds for obligation, the funds then are available for expenditure at the arsenal for two additional years, the same as if contracts had been placed with commercial concerns.

The Accounting Cycle

After the funds become available, the following steps are taken:

(a) Funds are recorded in the Treasury and subject to requisition.

(b) The Secretary of War apportions the funds to the Ordnance Department.

(c) The Chief of Ordnance apportions the funds to the various services.

(d) The services apportion the funds to the various projects.

(e) The arsenals are given procurement authorities.

(f) The arsenals incur obligations.

(g) Payments are made by the disbursing officers.

(h) Money papers are prepared and submitted for audit.

(i) Audit by the General Accounting Office.

(j) Finally, any unused balances are covered into the Treasury.

In closing I should like to make one statement: The wheels will not turn without money, and time spent in preparing good estimates pays very good dividends indeed.

The

American Society of Mechanical Engineers

Invites All Members of the

Army Ordnance Association

To Join In a Visit to

The United States Military Academy

West Point, New York Thursday, May 12, 1927

Special Boat will leave New York City at about 11 A. M. returning about 9:30 P. M. An interesting Program of Drills and Exercises by the U. S. Corps of Cadets has been arranged. Ladies are invited.

Complete Details Can Be Obtained From
Local Post Secretaries
And From The Secretary,
ARMY ORDNANCE ASSOCIATION,
806 Mills Bldg., Washington, D. C.

Concerning the Measurement of the Rate of Detonation of An Explosive

Capt. I. A. Luke, Ord. Dept., U. S. A.

ONE of the most important characteristics of an explosive is its rate of detonation. The rate at which an explosive wave travels through an explosive, under given conditions of initiation and confinement, is one of the factors that determines the effect which will be produced.

The explosive wave is peculiar to explosive phenomena. It was recognized as a kind of wave motion very soon after the advent of high explosives, and early investigators, M. Vieille and Berthelot, undertook experiments to ascertain the nature and characteristics of this form of energy. They examined the rate of propagation of an explosion in various gases, both mixed and unmixed, under varying pressures and under varied forms of containing vessels. The researches confirmed the existence of a wave motion produced by a certain concordance between the physical and the chemical impulses in the matter undergoing transformation. They found that the wave motion, once produced, is propagated from layer to layer throughout the whole mass in accordance with the successive impacts of the gaseous molecules which had been brought to a state of intense vibration by the heat given off in the reactions during the decomposition of the explosive substance, and this transformation with but slight displacement of the molecules' original position. The explosion wave is the moving system which receives its enormous energy and pressure from the chemical changes in the explosive, the ultimate result of which is the evolution of heat and gases. The wave is not periodic, but is a single characteristic wave and exhibits similar phenomena in solid, liquid, or gaseous explosives.

In the testing of high explosives, the time required for the explosive to develop its maximum pressure is a very important factor. The selection of an explosive for a detonator, for example, is based, among other considerations, on the blow it is able to render, rather than the total amount of energy liberated. The gamut of uses to which both military and commercial explosives are subjected requires the answer in one form or another: How fast is the energy liberated? What is the total quantity of energy liberated? The answer to these questions, other considerations such as stability, sensitivity to shock, heat, etc., hazards of manufacture, etc., being taken care of, determines the suitability of an explosive for a particular purpose.

The word "brisance" is used to describe the shattering effect of an explosive. In general, if one explosive is more brisant than another its energy is liberated at a faster rate; its rate of detonation is higher.

M. Bichel first proposed to use the kinetic energy expression $\frac{1}{2}mv^2$ as one which described the "brisance" or violence of the blow; m being the mass of gases evolved and v the velocity of the detonation. But practical tests indicated that $\frac{1}{2}mv$ gave a more nearly correct picture of the effect, and it, at best, is an expression for the total energy rather than for the intensity of an explosive reaction.

Later, another expression for "brisance," based on experiments in crushing lead cylinders, was developed as:

$$f\,U\,\Delta \times K$$

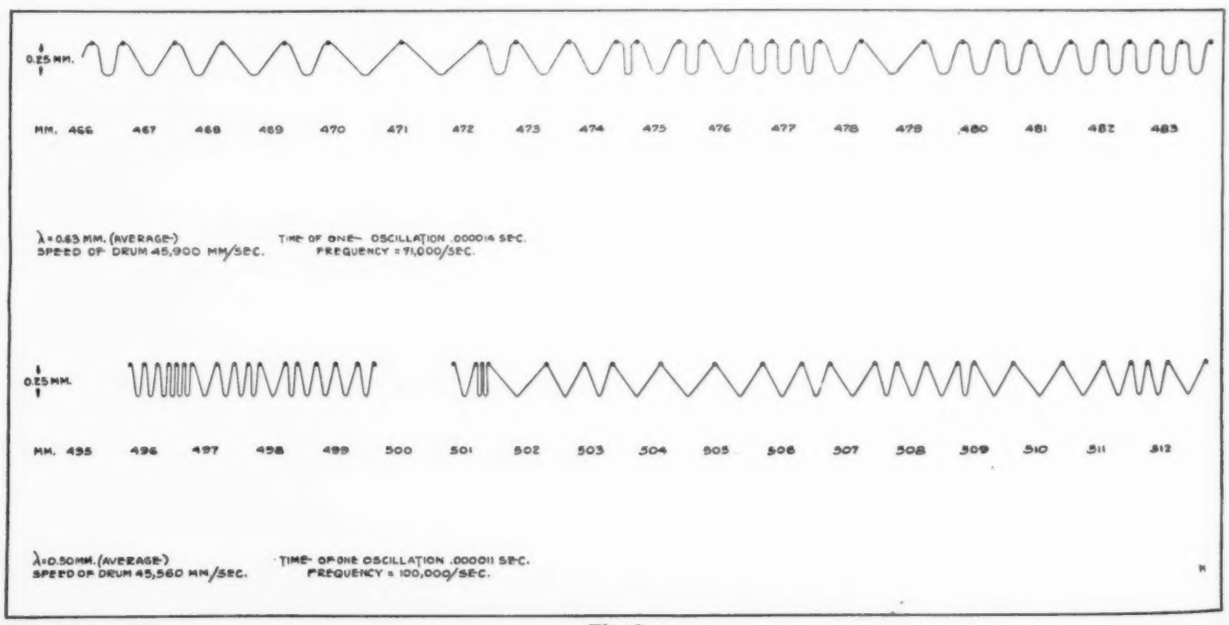


Fig. 1.

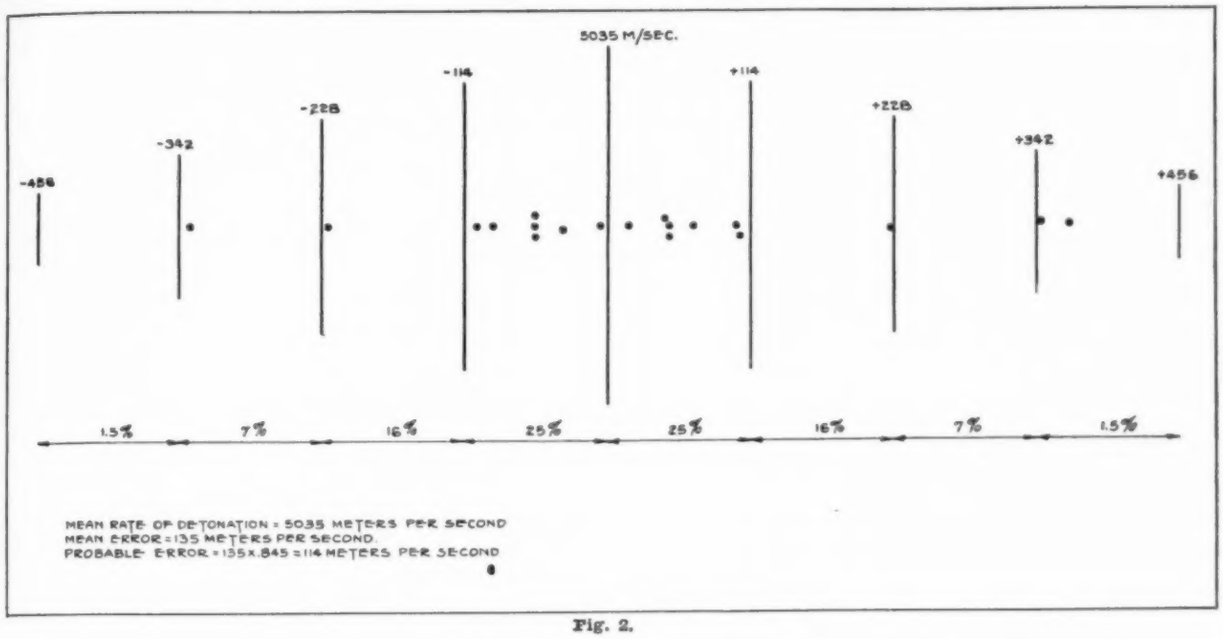


Fig. 2.

Where f is the specific pressure or characteristic force of an explosive,

U = velocity of detonation,

Δ = the density,

K = a constant describing the conditions of the test.

The force f is a characteristic of an explosive, and together with another constant, a, the covolume of the molecules, are called the Abel constants: f is proportional to the kinetic energy of the gases of explosion, and represents the work of the expansion of the gases under a constant pressure P_0 from a temperature T_0 to T_1.

Another way of describing this specific pressure f is that it denotes the pressure developed upon burning a unit weight of the explosive in a closed chamber which has a volume equal to the assumed unit of volume plus the covolume of the given body. The covolume a is defined as the minimum volume of the products of decomposition and its value for all smokeless powder and other explosive substances, other than black powder, is approximately equal to 1/1000 of the volume of gases evolved—these gases and water vapor being measured at 0°C and under a pressure of 760 mm. of mercury.

To illustrate the above, if 1 gram of picric acid gives off 877 cu. cm. of gases and water vapor (measured at 0°C and 760 mm. pressure), the covolume of the molecules amounts to 0.877 cu. cm. It is seen, then, that to arrive at the value of f for this particular explosive, the 1 gram should be burnt in a closed chamber of 1.877 cu. cm. capacity. This specific pressure f is obtained by one of these formulas:

$$f = F(1 - a) = RT_1 = \frac{P_0 V^1_0 T_1}{273} = .0038\ V^1_0\ T_1$$

Where F is the pressure corresponding to a density of loading of unity, and is connected up with the total pressure obtained in any measurement by the formula:

$$P = \frac{F(1 - a)\Delta}{1 - a\Delta}$$

$P_0 = 1.0333$ Kg/cm^{-2} or atmospheric pressure.

V^1_0 = Volume of gases evolved from burning 1 gram of the explosive and considering water as steam. (Measured or computed.)

T_1 = Absolute temperature $\left[\text{Computed by formula } T_1 = \frac{273 f}{P_0 V^1_0}\right]$

R = A constant = $F\left[\frac{(1 - a)}{T_1}\right]$

a = Covolume of the molecules = $.001\ V^1_0$

Again taking picric acid as an example, data are available as follows:

$P = 78626$ kg/cm^2 = F for Density 1.0;

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$R = 3.315$;

(Mallard and LeChatelier—*Memorial des Poudres et Salpetres*, Vol. II, p. 451-454.)

Hence—

$$f = 9671 \text{ kg/cm}^{-2}$$

As soon as the concepts of the explosive wave traveling with extreme rapidity were confirmed, Abel, Berthelot, Bichel, and other investigators began measuring the rates of detonation of various explosives.

One of the first methods was to detonate a long string of cartridges with two electrical circuits passing through the explosive at known distances apart. However, the chronographs used (the Boulengè, which depended on the law of falling bodies) and some others gave time readings to only a few ten-thousandths of a second, thus necessitating an explosive train up to as long as a hundred meters in length in some cases to secure a reading. This, of course, was a dangerous and expensive method.

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Concerning the Measurement of the Rate of Detonation of An Explosive

Capt. I. A. Luke, Ord. Dept., U. S. A.

ONE of the most important characteristics of an explosive is its rate of detonation. The rate at which an explosive wave travels through an explosive, under given conditions of initiation and confinement, is one of the factors that determines the effect which will be produced.

The explosive wave is peculiar to explosive phenomena. It was recognized as a kind of wave motion very soon after the advent of high explosives, and early investigators, M. Vieille and Berthelot, undertook experiments to ascertain the nature and characteristics of this form of energy. They examined the rate of propagation of an explosion in various gases, both mixed and unmixed, under varying pressures and under varied forms of containing vessels. The researches confirmed the existence of a wave motion produced by a certain concordance between the physical and the chemical impulses in the matter undergoing transformation. They found that the wave motion, once produced, is propagated from layer to layer throughout the whole mass in accordance with the successive impacts of the gaseous molecules which had been brought to a state of intense vibration by the heat given off in the reactions during the decomposition of the explosive substance, and this transformation with but slight displacement of the molecules' original position. The explosion wave is the moving system which receives its enormous energy and pressure from the chemical changes in the explosive, the ultimate result of which is the evolution of heat and gases. The wave is not periodic, but is a single characteristic wave and exhibits similar phenomena in solid, liquid, or gaseous explosives.

In the testing of high explosives, the time required for the explosive to develop its maximum pressure is a very important factor. The selection of an explosive for a detonator, for example, is based, among other considerations, on the blow it is able to render, rather than the total amount of energy liberated. The gamut of uses to which both military and commercial explosives are subjected requires the answer in one form or another: How fast is the energy liberated? What is the total quantity of energy liberated? The answer to these questions, other considerations such as stability, sensitivity to shock, heat, etc., hazards of manufacture, etc., being taken care of, determines the suitability of an explosive for a particular purpose.

The word "brisance" is used to describe the shattering effect of an explosive. In general, if one explosive is more brisant than another its energy is liberated at a faster rate; its rate of detonation is higher.

M. Bichel first proposed to use the kinetic energy expression $\frac{1}{2}mv^2$ as one which described the "brisance" or violence of the blow; m being the mass of gases evolved and v the velocity of the detonation. But practical tests indicated that $\frac{1}{2}mv$ gave a more nearly correct picture of the effect, and it, at best, is an expression for the total energy rather than for the intensity of an explosive reaction.

Later, another expression for "brisance," based on experiments in crushing lead cylinders, was developed as:

$$f\,U\,\Delta \times K$$

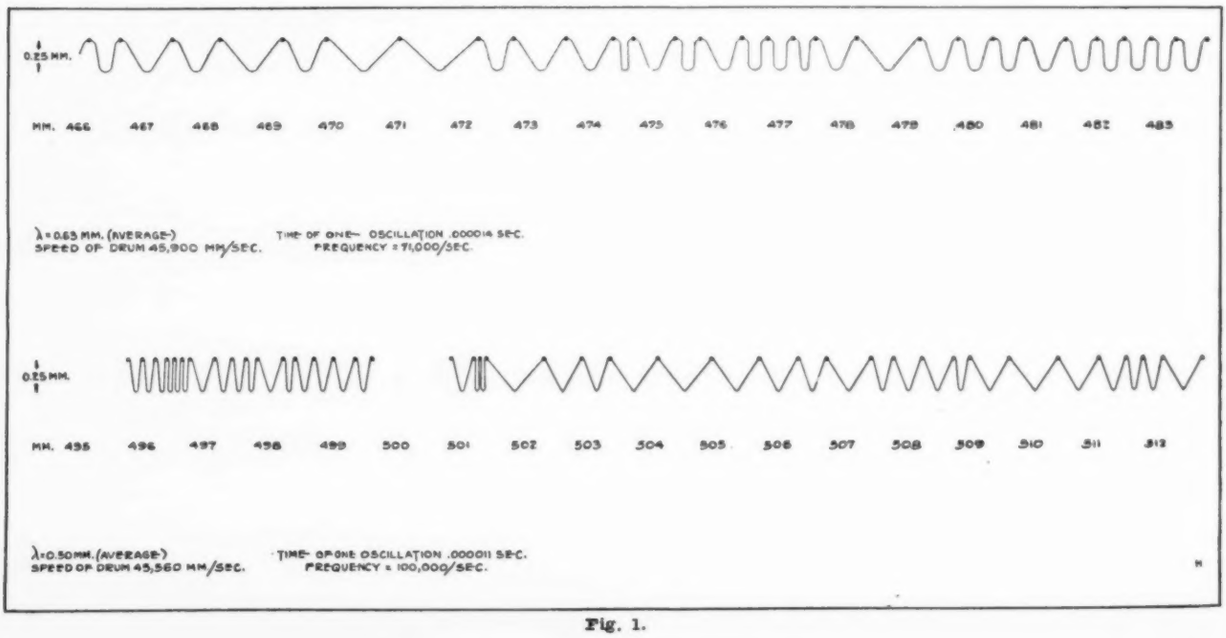

Fig. 1.

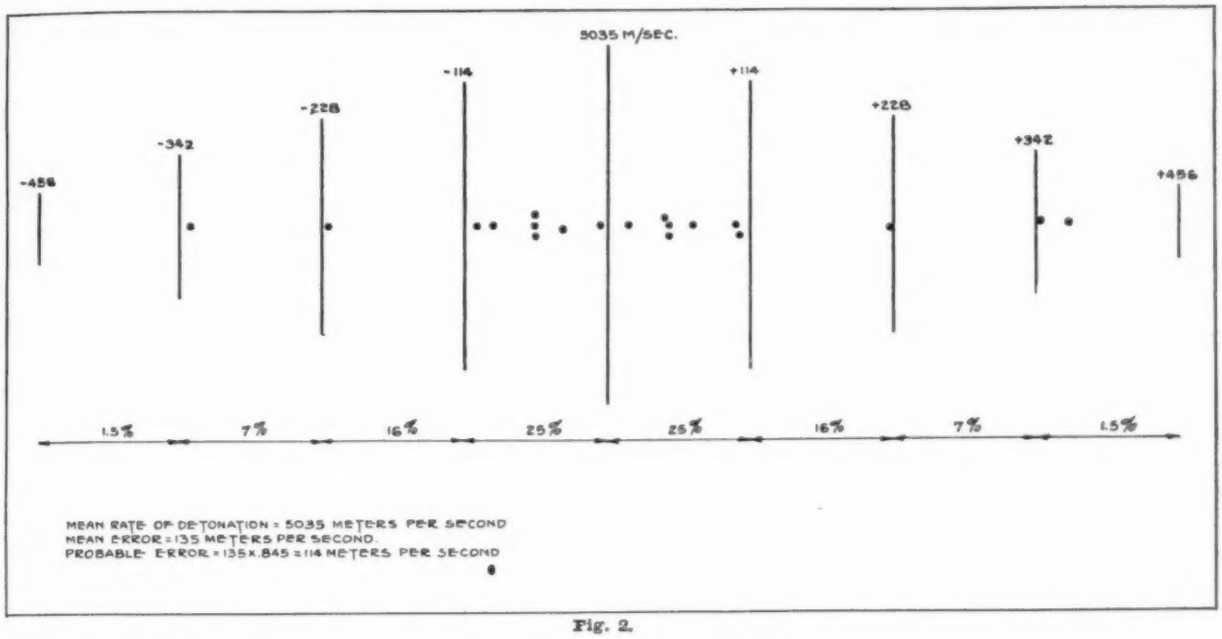

Fig. 2.

Where f is the specific pressure or characteristic force of an explosive,

U = velocity of detonation,

Δ = the density,

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rate of detonation are inserted in the column of test explosives at known distances apart. The ends of the fuse are laid opposite and parellel on a lead plate and the middle point between the ends marked on the lead plate. If the two detonators were fired simultaneously by the wave in the test explosive, equal lengths in the two detonating fuses would be travelled before meeting. But when placed as above stated, the first will travel farther than the second by a distance X. Hence, if U is the known rate of detonation of the fuses, V is the rate of detonation of the explosive under test, and d is the distance the detonators are apart:—

$$V = \frac{U \times d}{2X}$$

A practical apparatus, far in advance of former ones, was designed by Dr. Mettegang about 1908 for measuring extremely small time intervals, such as obtains in explosives work. This apparatus, known as the Mettegang Recorder, is the standard apparatus in use in all countries today, and it is identical in principle with the Queen Gray Recorder to be described later in this article.

The hook-up of the Queen Gray Recorder apparatus is shown in perspective on the schematic drawing (Fig. 3) and in photograph (Fig. 5).

A heavy steel base is bolted to a concrete pier and furnishes the support for the drum and the sliding rack and microscope.

The drum is a carefully machined and polished hollow steel cylinder, horizontally mounted on bearings which float in castor oil. The drum is 680 mm. in circumference and 28.6 cm. in length. One edge of it is divided into millimeters and the other edge is milled so that an endless screw may be made to engage with it in such measure that one turn of the screw moves the drum 1 mm. On the upper end of the screw is an index and a vernier divided into hundredths, thus making it possible to read to hundredths of a millimeter.

On one end of the drum shaft is a 2-inch diameter flanged pulley over which a stitched many-ply silk belt travels from the small 3 phase A. C. motor which furnishes the driving power. A belt tightener is mounted midway between the drum pulley and motor pulley to keep the proper tension on the belt. With the drum brought up to speed, the short lengths of belt involved, and the nature of the belt and pulleys, it is believed that any "slip" would be insensible.

Mounted over the drum by uprights bolted to the heavy base is a horizontal graduated piece of steel to which the sliding rack, containing 8 insulated platinum points and the 10-magnification reading microscope, may be clamped at any position over the drum.

On the other end of the drum shaft is a small diameter pulley over which a rubber belt travels and connects with the driving pulley of a magneto-generator tachometer, which in turn generates a current which is registered on a direct reading voltmeter in terms of revolutions per second for the drum. The current taken from such a generator is so small that the armature reaction is negligible, and the voltage generated is nearly exactly a linear function on the speed.

The principle of the tachometer is that a current is generated by the revolving of an armature in the field of a permanent magnet. The indicator for the magneto generator is a voltmeter designed to show instantaneous speeds of the drum from 50 to 150 revolutions per second. The rubber belt does not slip at running speeds, as there is no appreciable pull on the armature, and further, due to the ratios of the two pulleys concerned, there is little difference in tension between the upper and lower sides of the belt.

If different running speeds of the drum are desired, pulleys of different diameters are used on the motor which runs the drum. The pulley in use for most work in general gives a maximum speed of about 67 revolutions per second or a peripheral speed of 45.5 meters per second. This is considered a good working speed. In tests,

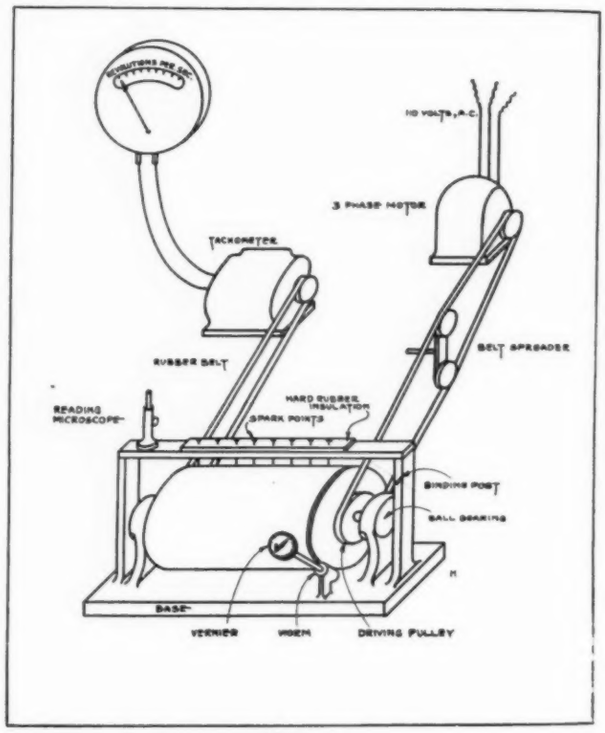


Fig. 3.

the drum has been operated at speeds as high as 115 revolutions per second, but this is considered hazardous. The Bureau of Mines at Pittsburgh uses a 4 spark point Mettegang Recorder with a peripheral speed of approximately 45 meters per second for ordinary work.

A maximum of eight induction coils may be used with the recorder and the wiring diagram as finally developed is shown in Fig. 4. The primary of the coil is connected in series with a key, ammeter and source of current, which consists of a group of storage batteries. The primary circuits are independent of each other and extend through the explosive column under test at the intervals desired. Around the primary is the secondary coil, of which one terminal is connected with one of the spark points and the other connected to the base of the recorder. When the current in the primary circuit is suddenly broken, as occurs when the explosive wave does it, a spark will jump from the platinum point to the soot covered drum and leave a crater thereon as a record.

Independent circuits were found to give better results

and to be easier to handle than the placing of all the primary circuits in parallel and fed from a power source of D. C. current. It was found that this latter scheme made it difficult to control the size of sparks produced in all circuits after the first, because the current was in a state of change toward a higher value as soon as one of the parallel circuits was cut out.

To obtain coils of the proper dimensions for a specific purpose was found to be largely a cut-and-try method. The calculation of the coefficients of self-induction and mutual induction can be accurately accomplished, however. The mutual inductance of the two coils, primary and secondary, is the e. m. f. in the secondary when the current in the primary changes at the rate of 1 ampere per second. The self-inductance L of a solenoid is defined as the ratio of the number of lines of induc-

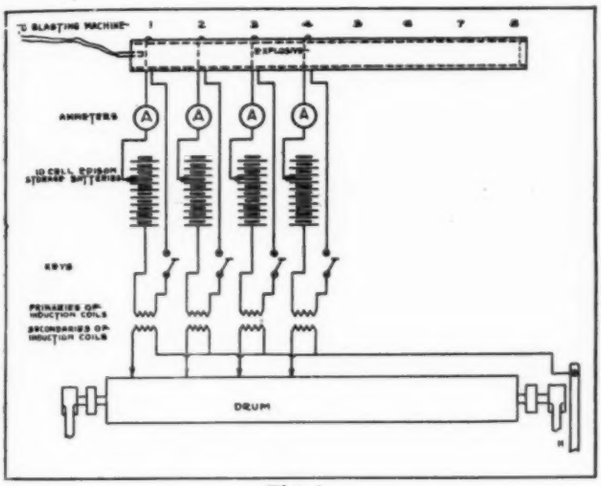


Fig. 4.

tion produced by a current flowing in the circuit divided by the current in the circuit.

Or for a long solenoid,

$$L = \frac{4\ \Pi\ n\ n^1\ A\ u}{10^9}$$ henrys, where

A = Cross sectional area in sq. cm.
u = Permeability factor.
n = Total turns.
n^1 = Number of turns per cm. length.

The factor u in the above is constant for air and equal to unity. If an iron core of any description is used the factor u takes on a value several hundred times as great as for air, and there is an uncertain lag in the current coming to a steady value upon make or break of the primary. Further, in an iron cored solenoid, the value of u changes, depending on the degree of magnetic saturation of the iron. For these reasons air core solenoids were developed.

Having a formula for obtaining the self inductance of each coil, the mutual inductance is obtained by the formula:—

$$M = \sqrt{L_1\ L_2}$$

The potential which is built up in the secondary circuit by a make or break in the primary circuit depends on the current which flows in the primary, the physical characteristics of the coils, as to length, cross section, turns, etc., and the suddenness of the break. The potential built up in the secondary is much greater on "break" than on "make."

The coils finally developed were of the following dimensions:—

A primary of 8 layers of double cotton covered No. 12 copper wire. Total length 17.6 inches, wound on a hardwood spool, 11 turns to the inch, average diameter 1.4 inches, total of 1549 turns.

A secondary coil of 3880 turns of No. 26 triple silk covered magnet wire wound inductively in four sections on a heavy hollow cardboard mandrel, each section separated by a fiber ring. The coil is 3 inches inside diameter and 14.6 inches long.

This induction coil gives a spark of the right dimensions with but small adjustments when currents of from 2.0 to 5.0 amperes are flowing in the primaries.

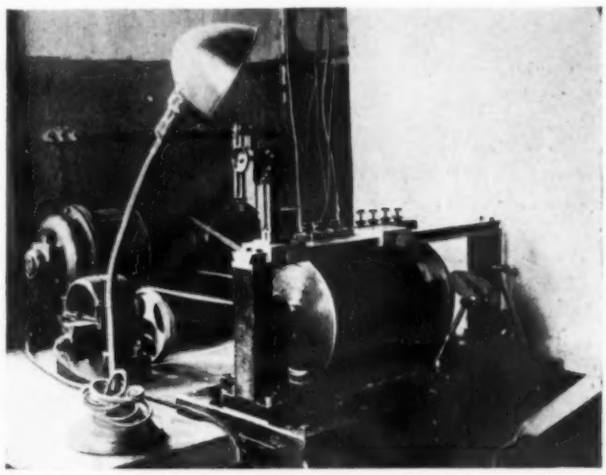


Fig. 5.

Referring again to Figs. 3 and 5, it will be noted that the spark points are held in position at a certain distance above the rotating drum. It is aimed to judge this length to gap to about 0.25 mm. The platinum point is firmly held in a brass screw with head and lock nut so that it may be lowered or raised at will. Hard rubber insulation keeps the charge from leaking off to the supporting rack of the base. The platinum point must be kept sharp in order to get a spark which will make a distinct crater on the drum. If a point becomes blunted, there is a tendency to get a brush discharge, and this reduces the accuracy in reading the craters on the drum.

This arrangement gives a case of two electrodes, the one a sharp point and the other almost a plane surface separated by a dielectric of insulating material, air. If a difference of potential is built up between them by applying an e. m. f., there is a critical potential at which a disruptive discharge occurs. This is called the minimum potential. The e. m. f. required to break down any particular dielectric depends on the shape and size of the electrodes, the distance between them and the nature of the dielectric. Air is a homogeneous dielectric of a specific strength of about 35,000 volts per centimeter. The difference of potential necessary (minimum potential to just break down a .025 cm. gap) would be something like 875 volts. It is thought that a working difference of potential is of the order of 2000 volts for a

pointed electrode above a drum, and this would mean a potential gradient of about 80,000 volts per centimeter across the gap.

The spark consists of a current of ions travelling with high velocity. The velocity of the + ions is 1.4-cm/sec. in air under a potential gradient of 1 volt per cm. The velocity of the negative ions is less. Assuming a potential gradient of 80,000 volts per cm. across the gap, it is seen that the jump is made with a speed of 1,120,000 mm/sec. or in a time of the order of 0.0000002 seconds. And when it is considered that there are two or more coils of the same characteristics approximately, any lags, if existent at all, would be negligible.

The soot crater produced on the drum can be pretty well controlled. The ideal one is a single spot in the soot not over a half-millimeter wide and showing, as most of them do, a tiny bright spot in the center where the electron stream strikes the metal with sufficient force to remove all the black. At times, it will happen that the first crater is followed by a series of further surges which leave their spots on the drum. This is caused by the fact that there was too much of a charge on the platinum point to escape at a single discharge.

Two examples of such oscillations are shown in Fig. 1. The small spots were measured on the drum, and it is seen that, knowing the speed of the drum and the average distance between spots, the time between successive oscillations can be computed. These times were, in the two cases shown, .000014 sec. (frequency 71000/sec.) and .000011 sec. (frequency 100000/sec.).

Following the installation of the Queen Gray Recorder, Cordeau Bickford 3 mm. detonating fuse was used for testing out the apparatus. At first ordinary run of fuse was tried. In each determination a length a few inches longer than a meter was used. Two small holes a meter apart were placed for the insertion of the No. 26 gage copper wire used to make the primary circuits complete. A No. 6 blasting cap was then taped end on to the end of the fuse for detonating the train. At first quite widely varying results were obtained because the fuse was laid on the ground, the wires running through the explosive were loose and the detonator placed too near the first wire.

If the detonator is too near the first wire, its action on the fuse in setting up the explosive wave may be of different degrees of violence, and in the first few inches the rate of detonation might be either higher or lower than the steady rate to which the explosive wave finally adjusts itself.

To secure comparable results with Cordeau, it is found necessary to use the greatest care in suspending and firing the fuse. The method which was used by the Bureau of Mines in some careful tests was adopted.

A wooden frame 4 feet long made of two 5-inch boards and held apart by four 5x5-inch pieces furnished the support of the fuse, which was threaded through ½-inch holes in the center. About 15 inches of fuse was allowed between the detonator and the first wire. The No. 26 insulated copper wires were stretched through the holes in the explosive and tacked to the frame to make them taut. A No. 6 electric detonator was carefully taped to the end of the fuse, and the whole ensemble suspended vertically in a bomb proof with the detonator end at the bottom. A specially selected coil of Cordeau-Bickford fuse was obtained direct from the Ensign Bickford Company for the tests. One series of 11 consecutive determinations using fuse from the outside end of the coil gave the folowing results:

Average rate of detonation.....5097 meters/sec.
Mean deviation from the mean.. 140 meters/sec.
Probable error ..... 118 meters/sec.
Maximum variation in series... 500 meters/sec.

A length of about 150 feet of the fuse was then sent to the Bureau of Mines for test with the Mettegang Recorder at that institution and a result of 5090 meters per second was reported for a mean of three determinations.

A further series of 10 determinations was run with the Queen Gray Recorder with the fuse and mean of 5200 meters/sec. was obtained with a mean deviation from the mean of 98 meters/sec. and a maximum variation in the series of 400 m/sec.

A final series of twenty determinations was made with the same selected Cordeau. This fuse was the last on the coil and required more straightening. All twenty determinations were successful in so far as securing a good record on the drum, and no result in the series was discarded:

Determination.	Speed of Drum mm/sec.	Distance between spots on drum.	Time for Wave to Travel 1 meter.	Deviation from Mean.	Rate of Detonation meters/sec.
1.	45900	9.04 mm.	.000197 sec.	+ 45 m/sec.	5080
2.	45764	9.01	.000197	+ 45	5080
3.	45560	9.16	.000201	— 55	4980
4.	45560	9.16	.000201	— 55	4980
5.	45560	8.90	.000195	+ 95	5130
6.	45560	9.19	.000202	— 85	4950
7.	45900	9.25	.000201	— 55	4980
8.	45900	8.50	.000185	+ 365	5400
9.	46036	9.02	.000196	+ 65	5100
10.	46036	9.22	.000200	— 35	5000
11.	45900	8.56	.000186	+ 345	5380
12.	45628	9.26	.000203	— 105	4930
13.	45560	9.06	.000190	+ 225	5260
14.	45560	9.84	.000216	— 405	4630
15.	45560	9.05	.000199	— 5	5030
16.	45900	9.09	.000198	+ 15	5050
17.	45900	9.02	.000197	+ 45	5080
18.	45900	8.97	.000195	+ 95	5130
19.	45560	9.71	.000213	— 335	4700
20.	45900	9.56	.000208	— 235	4810
	45756	9.12	.000199	135	5035

An analysis of the above results shows some interesting points regarding the accuracy of the apparatus and method of determining rates of detonation with the Queen Gray Recorder. The mean error is 135 meters/sec. The probable error, from the theory of probability, is 135 x .845 = 114 meters per second. This is the probable error to be expected due both to the apparatus and to the absolute variations in the rates of detonation in the fuse itself, which may be caused by such factors as variations in density, purity, cross-section and variations in the violence of the blow given by the detonator, even though this latter is at an estimated safe distance from the first wire.

The twenty determinations are plotted on the basis of the probability theory and the plot is shown in Fig. 2. The agreement with the theory is good. Exactly half of the results are higher than the mean and half less, and the distribution in percentage zones is slightly better than the theory predicts.

The probable error in per cent. is 2.3, representing a total probable error in time of .0000045 second. The

known sources of error in the apparatus and method are estimated as follows:

(a) Placing two wires in fuse to ± 1.5 mm. x .845 = 1.3 mm., representing a probable error in time of .00000025 second.

(b) Reading spots on drum ± 0.015 mm. x .845 = .013 mm., representing a probable error in time of .0000002 second.

(c) Reading tachometer after a steady speed is reached to ± 0.25 revolution/sec. x .845 = 0.22, representing a probable error in time of .0000006 second. The accuracy of the tachometer itself against a standard is not known but should reasonably be that of a high grade standard voltmeter.

The estimated known probable error is:

$$\sqrt{(.00000025)^2 + (.0000002)^2 + (.0000006)^2}$$
$$= \sqrt{.000\ 000\ 000\ 000\ 46}$$
$$= .00000068 \text{ sec.}$$

The probable error in time due to the fuse, then, is

$$\sqrt{(.0000045)^2 - (.00000068)^2}$$

or .00000445 sec., which would indicate that the probable errors of instruments and method are small compared with the errors in the fuse itself.

In conclusion, it may be stated that developments of other methods of measuring the rates of detonation of explosives are in progress in many laboratories. One of them consists in photographing the light from the explosive wave on a very sensitive film which is held to a drum revolving rapidly with its axis vertical. If the column of explosive is suspended behind a vertical slit and detonated from either end of the column, it is seen that the impression on the film will be an inclined line; the inclination depending on the speed of the drum, rate of the wave, and the relative distances of film, explosive column, and slit. In this method, the reasonable assumption is made that the luminous gases which furnish the source of light are identical with the explosive wave, the rate of which is being measured.

Another method is that of comparing the time of detonation in a column of explosive with the time of partial discharge of an accurate condenser through a known non-inductive resistance during the time that the detonation wave travels between two points at which electrical circuits are broken. (E. Jones, *Safety in Mines Research Board*, Paper 22, 1926.) Good results have been obtained by this method on columns as short as 25 cm., although in general the results were about 3 per cent. lower than Mettegang results for a meter of the same explosive.

And finally the family of oscillographs, varying from the vibrating string types of a frequency of 5,000 or 10,000 cycles per second to the cathode ray oscillograph with a frequency of the order of 50,000 or 60,000 cycles per second may be pressed into service to obtain further insight into the interesting phenomena of the explosive wave and how it "works" and travels.

A. O. A. Offers Prizes to West Point Cadets

THE Officers and Directors of the Army Ordnance Association, at their annual meeting in February, 1927, authorized the appropriation of one hundred dollars for prizes to be awarded members of the First Class, U. S. Military Academy, West Point, N. Y., for the best essays prepared on an Ordnance topic.

The First Classmen at the Military Academy have received the announcement with much enthusiasm as shown by the following notice which appeared in the March 11, 1927, issue of *The Pointer*—the bi-weekly publication of the Corps of Cadets:

"ARMY ORDNANCE—the journal of the Army Ordnance Association—is published in Washington and read by Army officers throughout the world and by civilians in America interested in Industrial Preparedness—in having the manufacturing resources of the United States so organized that, in the event of war, the plants normally producing peace-time commodities can turn to the production of munitions in a minimum of time. The Directors of the Army Ordnance Assocation are interested in West Point and they offer prizes aggregating one hundred dollars to cadets of the First Class who will submit articles suitable for publication in their magazine.

"Will you win? The following rules will govern:

"(a) The competition is open to members of the First Class of the United States Military Academy.

"(b) Manuscripts will be typewritten.

"(c) Articles must be suitable for publication in ARMY ORDNANCE.

"(d) Awards will be made as follows:

First Prize, most suitable article	$50.00
Second Prize	30.00
Third Prize	20.00

"(e) Articles must not be less than 3,000 words in length, exclusive of quotations. Photographs and drawings may be submitted in addition.

"(f) Articles must be submitted to the Professor of Ordnance and Gunnery on or before May 9, 1927.

"(g) Awards will be made by a Committee appointed by the President of the Army Ordnance Association.

"(h) Articles must contain nothing to indicate authorship. They must be signed with a nom-de-plume and must be accompanied by a sealed envelope containing the title of the article, the nom-de-plume, and the name of the author.

"The prize may go to the man who prepares a mathematical discussion of some abstruse ordnance theory; it may go to the lower section man who has an interest in some historical phase of ordnance development and a knack for expressing ideas in a clever style; or it may go to the cadet interested in the shop course, who will prepare a careful analysis of the methods used in the manufacture of one or more of the intricate models in the Ordnance Museum.

"The field is broad and suitable subjects are almost without number."

St. Louis Post, A. O. A., Established

THE fast growing roster of local posts of the Army Ordnance Association was brought to eight with the establishment of the St. Louis Post in that city January 18, 1927. Seldom, if ever, has a local organization of the Association been launched under more favorable auspices and with greater interest and enthusiasm.

The inaugural meeting of the new post was held in the ballroom of the Coronado Hotel, St. Louis, at seven o'clock P. M. The program began with dinner, at which 111 members were present. Following dinner the meeting was called to order by Mr. M. E. Singleton, Chief of the St. Louis Ordnance District, who briefly outlined the aims and purposes of the Association and read the following letter from Hon. Dwight F. Davis, Secretary of War, and telegram from Major General C. C. Williams, Chief of Ordnance:

"The Members of the St. Louis Post,
Army Ordnance Association,
care Mr. M. E. Singleton,
Chief, St. Louis Ordnance District,
St. Louis, Missouri.
Gentlemen:

I deeply regret that a previous engagement prevents me from being with you this day upon the occasion of the inauguration of the St. Louis Post of the Army Ordnance Association.

I am particularly interested in the work of this association. Since I have been in the War Department, I have had an opportunity to observe the far reaching influence it has had toward promoting an adequate national defense policy. It has given the industry of the country a better and a more national understanding of the problems involved in Ordnance manufacture in war, and has stimulated thought as to the solutions of these problems, which has already resulted in marked advances in Ordnance production planning.

You are fortunate in having with you Mr. Benedict Crowell and Brigadier General Ruggles, both of whom will address you upon the purposes and accomplishments of this association.

I wish, however, to congratulate you, my fellow-citizens, upon the organization of this post and I am confident that the advice, counsel and cooperation you will bring to the War Department through your interest in this association will be reflected in a better national defense.

I assure you of my deep interest in this Post and my confidence in you to maintain your place among the Posts of other cities.

Sincerely yours,
DWIGHT F. DAVIS,
Secretary of War."

"M. E. Singleton, Chief,
St. Louis District Ordnance Office,
Missouri State Life Insurance Bldg.,
St. Louis, Mo.

Please extend heartiest congratulations and best wishes to the officers and members of the St. Louis Post assembled for the inaugural meeting. They are cooperating in a very important movement and are due the thanks of all patriotic citizens who are interested in adequate national defense.

C. C. WILLIAMS,
Major General, Chief of Ordnance, U. S. A."

Lt. Col. E. D. Campbell, Ord. Res., chairman of the organization committee, was then called upon to present the constitution and by-laws which had been prepared by the committee for the government of the post. The chairman then appointed a committee of three members of the association, composed of Major W. C. Bliss, Ord. Res., Mr. G. L. Evans and Capt. C. T. Burgess, Ord. Res., to nominate officers and directors. The committee retired and after deliberation returned and reported the following nominees:

President: Col. Harry Scullin, Ord. Res., President, Scullin Steel Company.

Vice-President: Lt. Col. E. D. Campbell, Ord. Res., American Car and Foundry Co.

Directors for one-year term:

Mr. J. M. Kurn, President, St. Louis-San Francisco Railway Co.

Mr. J. W. Jarboe, President, Columbia Box Co.

Mr. A. J. Davis, President, Manufacturers and Merchants' Association.

Mr. E. D. Nims, President, Southwestern Bell Telephone Co.

Directors for two-year term:

Mr. M. E. Singleton, President, Missouri State Life Insurance Co.

Mr. W. F. Carter, Carter, Jones and Turney.

Mr. J. M. Olin, Vice-President, Western Cartridge Co.

Mr. H. I. Finch, President, The Emerson Electric Manufacturing Co.

Upon motion of Lieutenant Allen May, J. A. G. Res., the officers and directors nominated by the nominating committee were elected by acclamation. The chairman then introduced the president-elect, Colonel Harry Scullin, who took charge of the meeting.

Colonel Scullin is President of the Scullin Steel Company of St. Louis, which office he has held since the organization of the company twenty-seven years ago. He has taken a leading part in the development of the city of St. Louis and in the growth of the steel industry. He is President of the Associated Industries of Missouri; Chairman of the Citizens Terminal Committee of the St. Louis Chamber of Commerce; Vice-President of the Bond Advisory Committee of St. Louis; Chairman of the Manufacturers and Merchants Association; and an organizer and director of the Mercantile Trust Company, one of the largest financial institutions in the Middle West. Colonel Scullin is intensely interested in all matters pertaining to Industrial Preparedness.

Mr. Crowell's Address

Hon. Benedict Crowell, president of the Army Ordnance Association and former Assistant Secretary of War and Director of Munitions during the World War, made the following address:

"I am delighted to be with you tonight for the purpose of inaugurating the newly formed St. Louis Post of the Army Ordnance Association. During the past month I had the pleasure of attending a similar meeting in Philadelphia when a local Post of our Association in that city was established. I cannot tell you how pleased I am to see this phase of our Association activities grow. All of you are to be congratulated on the fine work which is being done here in St. Louis for munitions preparedness, both in connection with the official activities of the War Department and the District Ordnance Office and also in connection with this latest manifestation of your interest—the St. Louis Post.

"With the inauguration of this Post in St. Louis the Army Ordnance Association now has eight local organizations. These are New York, San Francisco, Chicago, Boston, Washington, Cincinnati, Philadelphia, and your own here in St. Louis.

"We believe that a local organization of this kind can be of tremendous value in stimulating cooperation in the excellent work for industrial preparedness which is being done by Mr. Singleton, the District Chief here, and his staff. We also believe that one of the best means of sustaining an interest in Ordnance activities generally is by such local groups as you have established here tonight. It is self-evident that an organization such as the Army Ordnance Association, which is nation wide in scope and which can exert only a limited amount of personal contact, must have some more direct medium of individual appeal. The annual meetings of the Association at the Aberdeen Proving Ground, affording as they do an excellent opportunity for getting together our entire membership, and the publication of our official journal, ARMY ORDNANCE, have, after all, their limitations in this respect and it is because of these limitations that we are glad to see established in our leading industrial centers local Posts where personal contact between our members may be made more intimate.

"The strides that are being made in the development of American ordnance are truly remarkable and should be a source of great pride to all of us. At the last annual meeting of the Army Ordnance Association at Aberdeen Proving Ground, October 8, 1926, there were some 3,000 visitors from all branches of American industry and engineering for whom some of these latest developments were demonstrated. The exhibits were truly marvelous.

"One development that particularly impressed me was the new fire-control instrument for use of the larger caliber guns against aircraft. Under the old system of antiaircraft firing (known as Case I), the gunner directed the gun in azimuth and elevation at the target by means of a telescopic sight. The additional lead of the plane was given by setting off lateral and vertical deflections obtained from a data computer and these corrections, together with the fuze settings, were telephoned to each gun crew. In this system much time was consumed in reading the data and telephoning it to the guns, with the result that eight seconds dead time was added within the instrument to the time of flight of the projectile.

The new instrument is so designed that, given the altitude of the plane, which is easily determined, the only action required is for one observer to follow the target's elevation and another to follow its direction, both through telescopes mounted on the instrument. The movements of these two telescopes control a mechanism which transmits electrically all firing data to the gun or guns. The data comprise the elevation and direction to be given the gun, so that the shell fired will intersect the path of the plane. The same instrument mechanically indicates the exact fuze setting that will explode the shell at the moment it reaches the intersection of the course of the plane and shell.

"This fire-contrtol instrument mechanically moves pointers on the gun and on the fuze setting machine. All that is required of the gun crew is to keep the gun set at the elevation and direction automatically indicated and to feed the ammunition into the fuze-setting machine and from there into the gun. The gun is a semi-automatic loader which has reached a rate of fire of 27 shots per minute.

"I might add that a very complete account of current developments of antiaircraft artillery, by Major G. M. Barnes, of the Ordnance Department, who is one of the foremost experts of the country on this subject, will be published in the next issue of our journal, ARMY ORDNANCE.

"And in like manner we are progressing in the entire field of antiaircraft ordnance. A new sound locator has been developed at Frankford Arsenal which is a vast improvement over the instrument used during and since the war. Multiple machine gun mounts, permitting the mounting of three and four caliber .30 or .50 machine guns, are being developed, with the result that the effectiveness of fire against aircraft has been greatly improved with these new weapons. The new 37-mm. full automatic Browning machine gun—the last contribution of the late John M. Browning to his already famous group of gun inventions—has great promise in antiaircraft gunnery. Then there are the new 3-inch antiaircraft gun, and the 105-mm. antiaircraft gun which throws a 33-pound shell to a ceiling of 45,000 feet. Both these guns gave very satisfactory results during tests conducted last summer.

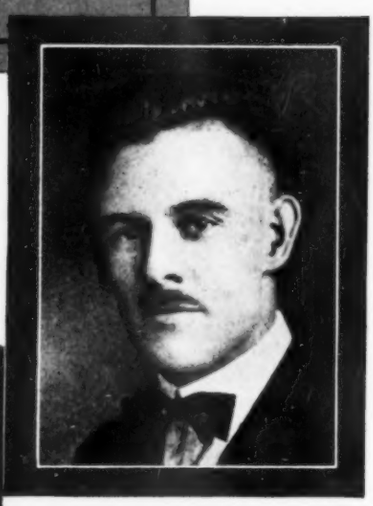
"In the category of field weapons, the same degree of progress can be noted. The American 75-mm. gun of latest design is a remarkable piece of work. It has just recently been adopted as standard for the Army. It is of the split-trail type with hydropneumatic recoil. It has a maximum elevation of 45° and with a 15-pound projectile has a range of 15,000 yards. Its possibilities are best visualized when we bear in mind that that old reliable, the French 75, used during the war had a range of 6,930 yards.

"What to my mind is an epoch-making piece is the latest 14-inch railway gun. This monster weapon weighs (gun and mount) 365 tons. The special truck or car carrying the gun itself is a system of four individual trucks with a total of 14 axles. The total height of the unit is 14 feet one inch, with a maximum breadth of 10 feet. It is 95 feet 4 inches in length and is so constructed that it can be used either on permanent emplacement or with troops in the field. The construction of this monster war piece is declared by Ordnance experts to be the latest word in modern weapons of large caliber, with the added distinction of being the largest and most powerful mobile gun in the American Army. One of these guns recently completed a

Officers and Directors

President
Harry Scullin
Colonel, Ordnance Reserve
President, Scullin Steel Co.

Vice-President
Lt. Col. E. D. Campbell,
Ord. Res.
American Car and Foundry Co.



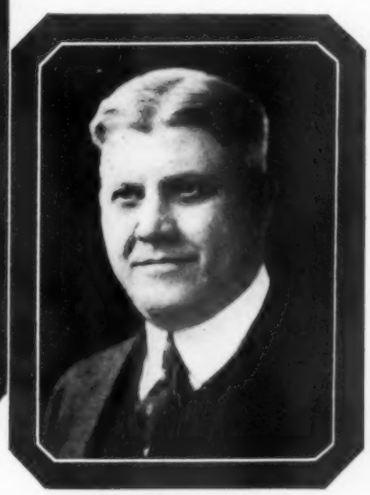
Treasurer
Lieut. Allen May, J. A. G. Res.
General Attorney, Missouri
State Life Insurance Co.

Secretary
Maj. C. M. Roberts,
Ord. Dept., U. S. A.
Executive Assistant, St. Louis
Ordnance District

Saint Louis Post, A. O. A.

A. J. Davis, Director
Pres. St. Louis Manufacturers and Merchants Assn.

M. E. Singleton
Director
Chief, St. Louis Ordnance Dist.



J. M. Kurn, Director
Pres. St. Louis-San Francisco R. R. Co.

W. Frank Carter, Director
Carter, Jones and Turney

J. W. Jarboe, Director
Pres. Columbia Box Co.

(Below)
J. M. Olin, Director
V.-P. Western Cartridge Co.

E. D. Nims, Director
Pres. Southwest'n Bell Tel. Co.

H. I. Finch, Director
Pres. Emerson Elec. Mfg. Co.

transcontinental trip from Aberdeen Proving Ground, Maryland, to Fort McArthur, California.

"Then, too, we have the new cross-country car—a slightly modified commercial vehicle capable of traveling over a terrain that might affect the disposition of even the well known army mule.

"There is the latest tank, known as the Medium Tank, with a newly designed 8-cylinder V-type tank engine, a product of the Packard Motor Car Company, which is capable of a cross-country speed of 16 miles an hour. This tank has armor protection against caliber .50 armor-piercing ammunition and carries one 6-pounder gun and two caliber .30 machine guns.

"And thus I might elaborate through the whole category of ordnance—ammunition, bombs, small arms, tanks, tractors and the rest.

"Now let us view these achievements in the light of our being here tonight. All these implements—and I have discussed only those that come to me at random—are modern ordnance which, if a major war should ever come again, must be produced in huge quantities and, more than that, they must be produced by American industry in a minimum of time. Other than a few manufacturing arsenals, six in all, there is no peace-time industry for the production of ordnance. In an emergency time will not permit of careful study or long preparation for the production of munitions.

"Based on experience, we of the Army Ordnance Association believe that a most helpful aid in the solution of this problem is an active organization such as ours, the members of which will have at all times an accurate and authentic knowledge of the complex requirements of American munitions. 'Peace insurance' in this form is the foremost aim of the Army Ordnance Association. This is the contribution of our Association toward industrial preparedness. As Colonel MacNider, the Assistant Secretary of War has said, 'The increasing interest all over the nation in industrial preparedness is a frank declaration to the world that we not only want peace but that we intend to have it.'

"As President of the Army Ordnance Association I want to tell you how greatly we appreciate your interest and cooperation. I am sure that the St. Louis Post will be a decided help in carrying on the very important work of industrial preparedness in which we are all interested, and I want to assure you that the Officers and Directors of the Association will always be willing and glad to assist you in every possible way.

"All the provisions of the Constitution and By-Laws of the Association pertaining to the establishment of local Posts having been complied with, it is a real pleasure for me, as President of the Association, to grant this charter giving formal recognition to the St. Louis Post."

The president then introduced Brig. Gen. C. L'H. Ruggles, Assistant to the Chief of Ordnance, who spoke of the work of the Army Ordnance Association and also of the Ordnance Department. He congratulated those present on their interest in Ordnance affairs and predicted a very successful field of activity for the new post.

Mr. W. Frank Carter, newly elected director of the St. Louis Post, was the next speaker. He urged all present to take an active interest in Ordnance affairs so that St. Louis might receive its proper mete of credit in this very important work.

Colonel Scullin then called upon Major C. M. Roberts, Ord. Dept., U. S. A., who made a brief talk concerning the proposed activities of the new post. The successful inauguration of the St. Louis Post was due in great measure to the untiring efforts of Major Roberts.

Colonel Scullin brought the meeting to a close with a stirring appeal to all members to make the new post a real factor in ordnance preparedness in the Middle West.

At a meeting of the board of directors of the new post, which was held immediately following the inaugural meeting, Major Roberts was elected secretary for a term of one year and Lieutenant May was elected treasurer for a term of two years. The following were present at the inaugural meeting:

Honorable Benedict Crowell, President, Army Ordnance Association.
Brigadier Gen. C. L'H. Ruggles, Assistant to the Chief of Ordnance.
Mr. M. E. Singleton, Chief, St. Louis Ordnance District.
Col. Harry Scullin, Ord. Res., President, Scullin Steel Co.
Major C. M. Roberts, Ord. Dept., U. S. A. Executive Asst., St. Louis District Ordnance Office.
Captain L. A. Codd, Ord. Res., Asst. Secretary, Army Ordnance Association.
Lt. Colonel E. D. Campbell, Ord. Res., Amer. Car and Foundry Co.
Major W. C. Bliss, Ord. Res., Scullin Steel Co.
Captain C. T. Burgess, Ord. Res., Burgess-Mason Printing Co.
Mr. F. Ackerman, Curtis & Co. Mfg. Co.
Mr. Fred B. Adam, Frank Adam Electric Co.
Mr. W. M. Akin, Laclede Steel Co.
Mr. Paul Aldress, St. Louis Forging Co.
Mr. Edward F. Ameling, American Brake Co.
Mr. Eugene G. Bailey, Fulton Iron Works.
Mr. E. A. Barnes, 2nd Lt. AG-Res., Missouri-Pacific R. R. Co.
Mr. A. J. Bechestobill, Pierce Petroleum Corp.
Colonel O. W. Bell, U. S. A., Org. Reserves, 102nd Div.
Captain H. N. Burkhalter, U. S. A., Jefferson Barracks, Mo.
Mr. Edmund Burke, Missouri State Life Insurance Co.
Mr. C. L. Chittenden, Schroeder-Tremayne, Inc.
Mr. Berthoud Clifford, Air Reduction Sales Co.
Mr. Edward F. Deacon, The Brecht Company.
Mr. W. F. Dietrichson, American Car & Foundry Co.
Mr. H. E. Doerr, Scullin Steel Co.
Mr. Geo. P. Dorris, Dorris Motors.
Colonel H. Dunwoody, Pres., Gardner Motor Sales Co.
E. M. Durham, Jr., V. P., Missouri-Pacific R. R.
Colonel H. E. Eames, U. S. A.
Mr. G. L. Evans, Wagner Electric Corp.
Mr. Chas. W. F. Campbell, Mound City Box Factory.
Mr. Geo. S. Chiles, Scullin Steel Co.
Mr. L. C. Farquhar, American Steel Foundries.
Mr. F. John Fehlig, Fehlig Bros. Box Mfg. Co.
Mr. W. C. Ferguson, Presstile Eng. Co.
Mr. H. I. Finch, The Emerson Electric Mfg. Co.
Mr. J. N. Foster, St. Louis-San Francisco Ry. Co.
Mr. Henry H. Fox, Fox Bros. Mfg. Co.
Mr. C. W. Frees, Curtis & Co. Mfg. Co.
Mr. H. B. Gardner, Westinghouse Friction Draft Gear Co.
Mr. R. P. Garrett, Missouri Bridge & Iron Co.
Mr. Paul Gebhardt.

Major C. E. Gotwals, U. S. A.
Captain Harry V. Hand, U. S. A.
Mr. Homer Hall, Gen. Attorney, Wabash Railway Co.
John R. Hall, U. S. Army.
Mr. E. S. Harrison, Curtis & Co. Mfg. Co.
Mr. A. L Heintze, Pierce Petroleum Corp.
Mr. L. B. Jandan, Commonwealth Steel Co.
Mr. Geo. R. Koeln.
Mr. W. H. Kopusch, Luedinghaus-Espenschied Wagon Co.
Mr. J. P. Larsan, St. Louis Millmen's Assn.
Mr. Paul Lehmann, Lehmann Machine Co.
Mr. E. D. Nims, Southwestern Bell Telephone Co.
Mr. Stanley B. Oakes, Northeastern Mutual Life Ins. Co.
Mr. Thomas O'Donnell, Mallinckrodt Chemical Works.
Mr. John W. Porter, American Steel Foundries.
Mr. Horace Raymond McCoy, American Steel Foundries.
Mr. P. J. McCullough, Scullin Steel Co.
Mr. Allen May, Utah-Idaho Central R. R.
Mr. G. T. Michael, Luedinghaus-Espenschied Wagon Co.
Col. Leroy K. Robbins.
Capt. H. E. Rogers, Ord. Res., Commonwealth Steel Co.
Col. W. C. Rogers, Ord. Res., Northeastern Mutual Life Ins. Co.
Lieut. J. E. Redford, Ord. Res., American Brake Co.
Lieut. W. E. Remmers, Ord. Res., Washington University.
Mr. H. M. Rischel, Amer. Steel Foundries.
Mr. Harry H. Ross, Pierce Petroleum Corp.
Mr. F. H. Schubert, Sherman Corporation.
Mr. R. O. Shive, Sterling Steel Co.
Capt. Ralph Slate, Jefferson Barracks, Mo.
Mr. Nathan A. Smith, Jefferson Barracks, Mo.
Mr. E. J. Spencer.
Mr. J. E. Stogsdill, Laclede Gas Light Co.
Mr. F. S. Thomas, Westinghouse Air Brake Co.
Mr. Carel T. Torresen, Standard Unit Navigation Co.
Mr. V. M. Transue, Western Cartridge Co.
Mr. James H. Tyrrell.
Capt. W. M. Valentine, Ord. Res. Instructor, Beaumont High School.
Mr. F. R. VonWindegger, Insurance Bank of St. Louis.
Mr. A. C. Waldvogel, Western Engineering Co.
Lieut. R. A. Williams, Ord. Res., American Car and Foundry Co.
Mr. R. W. Williams, V. P., American Brake Co.
Mr. C. C. White, Illinois Powder Mfg. Co.
Mr. T. E. Wood, Laclede Gas Light Co.
Capt. G. A. Yates, Ord. Res., Habirshaw Cable & Wire Corp.
Mr. Chas. H. Hempel, Missouri State Life Ins. Co.
Mr. H. I. Finch, The Emerson Electric Mfg. Co.
Mr. Edgar Gengenback, Scruggs, Vandervoort & Barney.
Capt. R. R. Stephens, Ord. Res., Elliott & Stephens Machine Co.
Mr. John B. Strauch, More-Jones Brass & Metal Co.
Mr. J. D. Robertson, President Engineers' Club, St. Louis.
Mr. H. R. Goss, St. Louis Car Co.
Mr. Geo. L. Kippenberger, St. Louis Car Co.
Mr. George W. Scruggs, St. Louis Car Co.
Mr. John H. Kuechenmeister, St. Louis Paper Can and Tube Co.
Captain E. H. Sager, Ord. Res., Washington University.
Mr. A. J. Davis, President, Manufacturers & Merchants Assn.
Mr. Chas. L. Knower, Lewis Invisible Stitch Co.
Mr. J. H. Singleton, Missouri State Life Ins. Co.
Col. Moor S. Falls, Jefferson Barracks, Mo.
Mr. J. T. Howard, St. Louis *Post Dispatch*.
Mr. W. F. Carter, Carter, Jones and Turney.
Mr. Walter Hecker.
Mr. Davis Biggs, National Bank of Commerce.
Mr. H. L. Gass, St. Louis Car Co.
Mr. S. W. Crawford, More-Jones Brass & Metal Co.
Mr. N. A. Doyle, American Car and Foundry Co.
Mr. O. Fink, St. Louis *Globe Democrat*.

BRIG. GEN. C. L'H. RUGGLES, Ord. Dept., U. S. A.

UPON recommendation of the Secretary of War, the President recently nominated General Ruggles for reappointment as an Assistant to the Chief of Ordnance with the rank of Brigadier General. The nomination was approved by the Senate March 1, 1927.

As chief of the Manufacturing Service, Office of the Chief of Ordnance, on which duty he will continue, General Ruggles is charged with the perfection of plans for industrial mobilization. His services have resulted in marked advancement in the plans for the procurement of ordnance supplies in the event of an emergency.

General Ruggles was born in Omaha, Nebraska, and entered the U. S. Military Academy, July 1, 1886. Upon graduation he was commissioned a 2nd Lieutenant in the Field Artillery. He transferred to the Ordnance Department in 1893 with which branch he has served continuously through all commissioned grades. He was appointed a Brigadier General and Assistant to the Chief of Ordnance in 1923.

During the World War, as a colonel, he selected the site for, constructed, and commanded the Aberdeen Proving Ground. In recognition of these services he was awarded the Distinguished Service Medal with the following citation:

"For exceptionally meritorious and distinguished service. The conception and construction of the Aberdeen Proving Ground and its operation during the early and most difficult period of its history are a monument to his sagacity and unremitting labor."

Appointed a temporary Brigadier General in August, 1918, General Ruggles was ordered to France to establish an overseas liaison with the French and British Ordnance Inspection Services and to inspect the artillery matériel of the American Expeditionary Forces.

Pittsburgh Post, A. O. A., Inaugurated

THE inaugural meeting of the Pittsburgh Post of the Army Ordnance Association was held at the Duquesne Club 6:30 P. M. Thursday, February 24, 1927. Prior to this meeting, ballots and the proposed draft of the constitution were prepared and mailed out to all members of the Army Ordnance Association who had petitioned the National Association for a local charter. The ballots were marked and returned and the constitution approved, so that all officers of the local post were elected prior to the meeting.

Mr. Ralph M. Dravo, Chief of the Pittsburgh Ordnance District, made a few introductory remarks and congratulated the Organization Committee on the splendid work which they had done in organizing the local chapter. Mr. Dravo then introduced Lieut. Col. Herbert A. Gidney, Ord. Res., Chairman of the Organization Committee. Colonel Gidney announced the result of the balloting as follows:

President: Taylor Allderdice, President, National Tube Company.

Vice-Presidents: T. M. Girdler, Vice-President, Jones & Laughlin Steel Corporation; J. Frank Drake, President, Standard Steel Car Company.

Directors: Ralph M. Dravo, Dravo Contracting Company; H. A. Gidney, Comptroller, Gulf Oil Corporation of Pennsylvania; J. Rogers Flannery, President, Flannery Bolt and Nut Company; E. T. Whiter, Regional Vice-President, Pennsylvania Railroad Company; H. P. Davis, Vice-President, Westinghouse Electric and Manufacturing Company; Frank B. Bell, President, Edgewater Steel Company.

Secretary: Captain Fred A. McMahon, Executive Assistant, Pittsburgh Ordnance District.

Treasurer: Maj. G. M. Sixsmith, Superintendent, Passenger Transportation, Pennsylvania Railroad Company.

Colonel Gidney told of the purpose of the Army Ordnance Association and spoke upon the group membership plan which is open to all individuals, firms, companies and groups controlled by American citizens and he urged upon the executives of all industrial organizations within the District to take out membership in the Army Ordnance Association. Colonel Gidney, who is Comptroller of the Gulf Oil Corporation of Pennsylvania, announced that Mr. George S. Davison, President of the Gulf Refining Company, and Mr. W. L. Mellon, President of the Gulf Oil Corporation of Pennsylvania (the parent organization of the Gulf Refining Company), heartily endorse the group membership plan and that they had sent in a petition for group membership in the Army Ordnance Association.

Mr. Dravo then introduced Mr. T. M. Girdler, Vice-President of Jones & Laughlin Steel Corporation, who, in the absence of Mr. Taylor Allderdice, President of the Pittsburgh Post, acted as chairman of the meeting.

Mr. Girdler introduced Mr. F. J. Kress, President of the F. J. Kress Box Company, whose firm is allocated to the Ordnance Department for survey. Mr. Kress, who also represented the Chamber of Commerce at this meeting, welcomed the Pittsburgh Post of the Army Ordnance Association to Pittsburgh and promised that the Chamber of Commerce would be glad to do anything in its power to help further the cause of industrial preparedness.

General Ruggles' Address

General C. L'H. Ruggles, Assistant to the Chief of Ordnance, was then introduced and in behalf of Hon. Benedict Crowell, President of the Army Ordnance Association, who was unable to be present at the meeting, presented the charter to the local post. General Ruggles stressed the point that the Association is pledged to public service in effecting industrial preparedness for war as our strongest guarantee of peace.

He said: "There has been a gradual but most important change in the character of effort that must be put forth by a nation when it engages in war. This gradual change may be said to have reached its maximum in the World War. In the early days wars were fought by professional armies and there was relatively little disturbance of the economic life of the nation caused by such wars, except in the territory of the theater of operations. Nowadays, as you all know, all the man power of the nation that can be spared is drafted for the war which is fought essentially by civilian armies with a leaven only of professional soldiers. But even more important than this change is that relating to the equipment that must be furnished modern armies. In the early days, providing a nation could furnish the necessary man power, it was relatively easy for it to secure the weapons, mostly hand weapons with a small amount of artillery of simple construction which was relatively easily manufactured, the guns in an iron foundry and the carriages by ordinary carpenters, wheelwrights and blacksmiths. The amount of powder required also was relatively small and it was of the type that could be easily produced. In these modern days all this is changed. The equipment used by modern armies is tremendous in its amount and very complicated and scientific in its construction. To furnish this equipment for a modern army requires all the industrial resources that the most important manufacturing countries can spare after providing for the necessities of the civil population, and even in those countries that possess the largest industrial resources it is not practicable to furnish the troops from production started after war is declared with munitions in the requisite amounts as rapidly as man power can be mobilized and prepared for battle. Thus industrial mobilization for war is coming to be recognized as a much more difficult task than the mobilization of man power for war.

"The industrial effort to maintain armies in action may be measured approximately by the expenditures of artillery ammunition, and so I think it will be interesting, as a means of visualizing the increased effort now required on the part of industry in a major war, to give some comparisons between the expenditures of ammunition in the World War and the expenditures during our Civil War. For example,

Officers and Directors

President
Taylor Allderdice
Pres. National Tube Co.

Vice-President
T. M. Girdler
Vice-Pres. Jones & Laughlin Steel Corp.

Vice-President
J. Frank Drake
Pres. Standard Steel
Car Co.

Director
Ralph M. Dravo
Chief, Pittsburgh
Ordnance District

Director
Lieut. Col. J. Rogers Flannery, Ord. Res.
Pres. Flannery Bolt & Nut Co.

Director
Lieut. Col. Herbert A. Gidney, Ord. Res.
Comptroller, Gulf Oil Corporation.

Pittsburgh Post, A. O. A.

Director
H. P. Davis
Vice-Pres. Westinghouse Elec. & Mfg. Co.

Director
E. T. Whiter
Vice-Pres. Pennsylvania R. R. Co.

Secretary
Capt. F. A. McMahon,
Ord. Dept.,
U. S. A.,
Executive Assistant
Pittsburgh Ordnance
District.

Treasurer
Maj. G. M. Sixsmith,
Ord. Res.
Supt. Passenger
Transportation,
Pennsylvania R. R.,
Central District.

Member, Organization Committee
Lieut. Col. Wm. M. Hogg, Ord. Res.
National Tube Co.

Member, Organization Committee
Lieut. Col. G. P. McNiff, Ord. Res.
National Tube Co.

at the battle of the Somme in the World War the British fired approximately 4,000,000 rounds of ammunition, weighing 75,000 tons, whereas during the battle of Gettysburg only 32,781 rounds, weighing less than 400 tons were expended by the Union Army. To haul the ammunition used by the British would require 1,500 freight cars of 50 tons capacity, whereas the artillery ammunition expended by the Union forces at Gettysburg would require only 8 such cars. The total amount of ammunition expended by the Union Army in the Civil War was 5,000,000 rounds, being only 25 per cent. in excess of the number of rounds expended by the British in one battle during the World War. The number of rounds of ammunition consumed during the last year of the Civil War by the Union Armies was 1,950,000. The amount consumed by the French and British alone during the last ten months of the World War was 152,500,000 rounds. The weight of the average round used during the Civil War was 12 pounds, and the weight of the average round during the World War was 40 pounds. The average cost of a round of ammunition during the Civil War was $2, and the average cost of a round during the World War was $50. The total expenditure for ammunition used by the Union Armies during the Civil War was $10,000,000, and by the Allies during the World War it was $30,000,000,000. Incidentally, it may be added that it has been calculated that the total cost to the world of the World War, including such indirect costs as property losses, loss of production and the capitalized value of human life was about $338,000,000,000.

"You all know perhaps that it took the Allies approximately three years to attain maximum production of munitions during the World War, and furthermore quantity production was not attained until about two years after the war started.

"There is ample testimony from commanders on both sides that the critical shortage of munitions for the first year or year and a half paralyzed the fighting power of their armies, at times threatened whole sections of the front with disaster, and resulted in the stalemate of trench warfare which lasted for nearly four years.

"To anyone who has studied the situation at that time, it is evident that if either side had a sufficient supply of munitions it could have kept its opponent on the move in the fall of 1914 and have ended the war in its favor at that time.

"Now there are two ways by which we can arrange for a preponderating supply of munitions in case we are so unfortunate as to become again involved in a major war—one is by keeping the necessary munitions on hand in time of peace, and the other is by maintaining a smaller and more logical war reserve and organizing our industries to insure our getting into quantity production after war is declared before our enemy can.

"The first method, that is keeping on hand at all times sufficient munitions to last throughout a major war, is illogical because of the tremendous cost involved and because it is not essential, although we have the financial resources to enable us to do it if we wished.

"The second method is entirely practical at but a fraction of the cost of the first, and is so because of our tremendous industrial development, greater than that of any other nation in the world, and because we are specially favored in the matter of raw materials, most of the essential materials being found within our own borders.

"As you know, the National Defense Act provides for industrial preparedness and charges the Assistant Secretary of War with supervision of the plans we, in the War Department, are making to that end. You also know how the country is divided into procurement districts, each in charge of a chief, how requirements have been computed and allocated to the Districts and by the Chiefs thereof allocated to individual plants in the Districts. You are aware that a majority of the firms who have accepted allocations for munitions to be manufactured by them in the event of war are making factory plans for such production and, based on these factory plans, prospective subcontractors are being selected who in turn are making factory plans for the materials and parts they have agreed to furnish the prospective prime contractors.

"Now all this planning depends for its success on the cooperation of industry and this cooperation not only has been most public spirited and encouraging to the War Department but it has been growing as time goes on. The increasing interest and cooperation of manufacturers in this work results from their increasing knowledge of our plans and because they have studied the proposition as presented to them and have found merit in it.

"The Army Ordnance Association has been of the greatest assistance to the War Department by enabling manufacturers to become familiar with our preparedness problems and by enlisting their interest in and sympathy with the work we are doing. The association is living fully up to its pledge.

"But while we all have made great progress in the important work of industrial preparedness, there is yet much to be done before we reach that ideal state where we can say that our plans are so complete that nothing that can be provided for by careful planning in time of peace has been overlooked to cause confusion and delay after war is declared.

"Speaking more specifically of what the members of the Association are doing and can continue to do with the best results, there is still the necessity of bringing forcibly to the attention of our people that, while our industrial strength is tremendous, it cannot be effective in a military sense until it is thoroughly organized in time of peace; and that in this respect we are handicapped by the fact that we have practically no private munitions industry in this country, while practically all the private munitions factories in the world are located in Europe where, should we lose command of the sea, they will be available to our enemy and denied to us. Our arsenals are capable of producing but a small fraction of the munitions we would need in the event of a major war.

"Our ammunition reserves are not sufficient to carry us over the period that must elapse in the event of a major war until production can be obtained sufficient to fill the requirements of our troops, notwithstanding the fact that we are counting on the industrial plans we are now making to enable us to furnish ammunition to our troops in much less time than we did during the World War, or in much less time than any other combatant in the World War was able to supply its troops. Furthermore, our ammunition is about nine years old at the present time, whereas it has generally been assumed that small arms ammunition would

only remain serviceable for about ten years, while artillery ammunition would only remain serviceable for about twenty years. Those of you who are accustomed to hunt game might consider how you would like to use in your shotguns or rifles ammunition that is twenty years old. While we have been allowed small sums for the manufacture of ammunition since the World War, it has only been to provide on a small scale for some of the existing deficits of ammunition in our overseas possessions. However, we contemplate starting on a replacement program for ammunition during the fiscal year 1929. This program is based on replacing our present reserves of small arms ammunition in ten years and our present reserves of artillery ammunition in twenty years. But it must be remembered, as I have already said, that our ammunition now is about nine years old.

"Then there is the matter of new types of matériel. We have made vast improvements in the effectiveness of our weapons since the World War, but have only been able to make a few of each type for limited test at the proving ground and in service. We are hoping to persuade Congress through the Budget to permit us to manufacture a limited quantity of these new types, spreading the cost and therefore the amounts manufactured over the next ten years. It is quite necessary to manufacture limited amounts of these new types in order to give more thorough trial to our designs and to develop any weaknesses that may occur by extended use in actual service. It is also very essential to determine the best methods of manufacturing this material; to determine whether the designs are best adapted to quantity production; to determine the best types of jigs, fixtures and gages required, and to accumulate a limited supply of these very essential accessories for manufacture. But even if this authority is given by the Congress, ten years is a long time and, in view of the limited expenditures required, it is hoped that later on Congress may be willing to appropriate larger amounts for this purpose, so that the time when these new types can be said to have been thoroughly developed and ready for quantity production may be advanced.

"Then to those of you who are familiar with our factory plans the question of what we call educational orders must appeal very strongly. We desire so far as it is possible to give to each manufacturer, who has agreed to make munitions for us in the event of war, a small order for the same material that he would manufacture in the event of war, in order that he may get practical experience in the manufacture of the material and may get at least one set of jigs, fixtures and gages for such manufacture. You can see how much action of this kind would assist in obtaining early production from private plants in the event of war. Such a law is now before Congress. It will require an exception, with the approval of the Secretary of War and for the purpose of industrial preparedness, to that part of the National Defense Act which requires all manufacture of munitions to be done at Government arsenals. It will also require, for the purposes mentioned above, an exception to the general laws requiring acceptance of the lowest responsible bid for Government work. It will undoubtedly cost the Government more than the manufacture of the same articles in Government arsenals, but we consider that this extra cost will be an excellent insurance against war. If this Act is passed it will be very helpful in connection with our project for a limited amount of manufacture of new types of weapons and in connection with the gradual replacement of our war reserves of ammunition which we hope to commence during the fiscal year 1929.

"Then there is the question of more liberal provision in the Ordnance Department itself for carrying on the work of industrial preparedness. We need more officers and we need more funds to develop new and quicker methods of production of existing material. For example, take the case of the experiments made by the National Tube Company in the manufacture of shells from seamless drawn tubes. We would like to carry on the manufacture of shells by this method during time of peace, but we will need considerably more money for this purpose than is now available. We have many forgings for projectiles on hand now left over from the World War and, owing to the shortage of appropriations, we have been forced to base our estimates for such ammunition as we are now making, mostly for experimental purposes, on using these forgings. If we had more money we could make these shell out of tubing and we are now investigating the subject with a view to finding out whether we are able to use tubing for the manufacture of shell without materially increasing our costs over our present estimates.

"Finally, in discussing industrial preparedness, the members of this Association should point out continually the preponderating influence of an abundant supply of munitions in deciding a modern war. Given anything like an equality of man power, that combatant will win the war which can supply its troops with an overwhelming amount of munitions before its enemy can, and the sooner it does this, the sooner will it win the war, with all that this means in the saving of lives and money.

"But we can go even farther than this—we can truthfully say that industrial preparedness is the most practical and economical method of preserving peace for our country that has ever been devised. With our superb man power organized and trained under the National Defense Act, backed up by our tremendous industrial power also organized under that Act and prepared, through the patriotic cooperation of our manufacturers, to supply our troops with munitions at a rate greater than our adversary can hope to supply its troops, we will have a guarantee of continued peace with honor that will be almost absolute, for under the conditions I have described no nation and practically no combination of nations will venture to attack the United States."

Mr. C. W. Heppenstall, president of the Heppenstall Forge and Knife Company, mentioned a few of the difficulties experienced by his organization during the World War in getting into production on gun forgings. He also said that with the excellent system now in force, of enabling the manufacturers to study the drawings and specifications in peace time that practically all difficulties would be eliminated and that no doubt they would be able to get into production within thirty days after the outbreak of any war.

Maj. Charles Yon, Ord. Res., congratulated the organization committee on its splendid work in bringing the local post to Pittsburgh and requested that the minutes of the meeting be published so that all members of the As-

sociation could be better armed in their work for national defense and industrial preparedness.

Mr. J. H. Nicholson, Vice-President of the National Tube Company, was then called upon and said:

"It is believed the Ordnance Association company plan of membership has great potential value if the individuals comprising such memberships are selected from the active and practical employees of the company and who occupy key positions in the operating and production departments of the different plants. On such men would fall the responsibility of reorganizing the existing plant facilities so as to promptly turn out ordnance supplies in case of war.

"When such condition should arise, we must assume that the use of the company's plants demands very prompt action. The company must rely on its own industrial organization in such an emergency, and in a large majority of the cases it will be necessary to quickly adapt existing facilities to new uses. This can only be done promptly and to good advantage by those familiar with the equipment and operation of the plant, such as the general superintendents, master mechanics, plant engineers, department foremen, and such other employees who know, have direction and charge of production operations carried on with plant equipment.

"In order to secure prompt action and cooperation, such men must, in advance, be sold the idea of the necessity of preparedness. They must be solicited and encouraged in interesting themselves in ordnance problems. They must be made to feel that they can contribute to the solution of these important problems if the plans of the Ordnance Association are to be of any great value.

"The interest and assistance of executives of industrial organizations are important to the Association, but they will fall far short of the real service they can render unless they are backed up by the close cooperation of the operating and producing heads of the manufacturing plants. They are the men on whom we must rely to do the real work if a war emergency arises, and some way should be found to interest them and give them a part in the preparedness program of the Ordnance Association.

"In taking company memberships in the Association, it is suggested that every effort be made in seeing that this type of man is selected by the different companies who have committed themselves to cooperate with the program of the Association. If the problem of determining the best plan of promptly getting into production or securing the greatest output were put up to a group of practical men working in the different plants, we could be sure that when they determine on the best plan to bring this about that the Ordnance Department would have some very valuable and dependable information. In addition to this practical object backing up the idea of developing information there is the further thought that the Association will have aroused the interest and educated a force of trained, practical men in the ranks of industry who would mold opinion and who would become advocates of the necessity of National preparedness.

"If the suggestions made are thought to be sound and are proper activities for the Ordnance Association to encourage, it is believed that a more specific plan could be devised to bring about the objects mentioned, and it is hoped that the Association will give the suggestions some consideration."

Practically all Ordnance Reserve Officers resident in Pittsburgh were present at the meeting and the following industrial concerns and organizations were represented: Allegheny Steel Company, Aluminum Company of America, American Bridge Company, Blaw-Knox Company, Carnegie Steel Company, Chamber of Commerce, Crescent Portland Cement Company, Dravo Contracting Company, Flannery Bolt and Nut Company, Graham Bolt and Nut Company, Gulf Oil Corporation of Pennsylvania, Gulf Refining Company, Heppenstall Forge and Knife Company, Jones & Laughlin Steel Company, F. J. Kress Box Company, National Lead and Oil Company, National Tube Company, Pennsylvania Railroad Company, Pittsburgh Athletic Association, Pittsburgh Box Company, Pittsburgh & W. Va. Railway Company, Runyan Steel Company, Standard Engineering Company, Standard Sanitary Manufacturing Company, West Penn Power Company, Wheeling Mold and Foundry Company, Pittsburgh Steel Company.

The Centennial of Fort Leavenworth

A HUNDRED years of history now look back upon the military post established on a high bluff overlooking the Missouri River, about thirty miles northwest of Kansas City, by Gen. Henry Leavenworth in 1827. It was named in honor of the soldier who caused the first crude fort to be erected as defense for the early frontier, and from it have gone forth to the wars since that day men who have played important roles in the nation's military history. Albert Sidney Johnston, Sherman and Kearney were there before the Civil War. Alexander Doniphan's daring expedition to Mexico began its march from Ft. Leavenworth.

The old infantry and cavalry school was established in 1881 through the efforts of General Pope and General Sherman, the latter then commanding the army. Col. Elwell S. Otis, later distinguished in the war with Spain, was the first commandant. From a school at first intended to carry on the general education of junior officers, it gradually extended its scope and finally evolved into an institution devoted to the training of officers for command and general staff work.

It was the World War and America's part therein that demonstrated the value of the Ft. Leavenworth school. When four million men were mobilized and half of them sent overseas into battle, it was said that "Leavenworth ran the army." It was literally true. High commanders had attended the school either before or immediately following the war with Spain. Many of the division commanders had been students there and virtually every one had as his chief of staff a recent Ft. Leavenworth graduate. At A. E. F. headquarters, a visitor noting names on doors and desks would have thought he was back on the banks of the Missouri, rather than at Chaumont, France. (*Kansas City Star, March* 20, 1927.)

The Manufacture of Ordnance In Virginia During The American Revolution

Part II.

Kathleen Bruce, Ph.D.*

JOHN REVELEY, constructor and manager of the newly built Westham iron works, accompanied by John Onions, his right-hand man, set out early in December on a quest for skilled casters of cannon. The search, lasting almost two months, carried the two men as far north as Elkridge, Maryland; then having apparently accomplished their aim they returned to Westham in deep snow about the end of January. In another month Reveley had assembled a body of white laborers and negro slaves, and early in March with the entrance of spring regular work in the state-owned foundry of Westham began.

But already the evil of linking the project with Ballendine had arisen. No sooner was the foundry completed than someone discovered that unless the Commonwealth materially aided Ballendine in building the canal, the mills could not run for lack of water. Accordingly, the assembly authorized him money advances, until in 1779 he owed the Commonwealth over two thousand pounds on the canal. The debt on the canal might have been overlooked had his pig iron venture proved successful. In November, 1777, Ballendine and Reveley petitioned the assembly for an additional twenty-five hundred pounds which was granted. Their blast furnace provided the first pig iron which the Westham foundry used, but the Buckingham works could not maintain the promised quota, and in 1780 owed the state of Virginia 761 tons of pig iron. With apparently honest intentions Ballendine's reach exceeded his grasp; and whether due to the man's incapacity or to the hindrance of a war deranged period, his failure disgusted Governor Jefferson, so that in 1779, with the aid of the House of Delegates, the Governor attempted to transfer the Westham works from the control of Ballendine and Reveley to that of a successful French company. Simultaneously the French government, also at war, albeit our ally blocked the passage from France of manufacturers of ordnance. The Jefferson-Penet, Windle and Company scheme collapsed, and Ballendine and Reveley remained in possession. Like a second old man of the sea, Ballendine could not be shaken from unwilling shoulders and continued to obstruct the smooth running of the state works. Reveley, on the other hand, in spite of the toils of his partner which beset him until his death and in spite of Jefferson's pessimism appears to have served the state creditably.

Account books opened in February, 1779, show that active business began the following month. Henceforth the air furnaces manufactured for sale those iron wares needed on Virginian plantations, and in April Reveley began to produce cannon balls, grape, and canister shot which he continued unceasingly to make until 1781. Until September, 1779, he appears to have cast no guns and to have bored none before December. The first cannon actually sent out from Westham seem to be six four-pounders and two six-pounders, each of which weighing between eight and nine hundred pounds were charged to Ross Shore and Company on May 3, 1780, and wagoned to Richmond with two swivels to carry twelve-ounce balls. A few weeks later, eight guns, half of which were six-pounders and half four-pounders, are listed in quick succession against the account of Zachariah Rawling. On June 4, a six-pounder appears charged to the State of Virginia. Meanwhile, Colonel Benjamin Harrison had sent one order for twelve six-pounder cannon and, also, for swivels, ball, and grape shot. On September 2, John Reveley announced the completion of the order with the exception of the grape shot, of which, however, there was apparently enough stored in Richmond of the last year's stock from Westham foundry to supply Colonel Harrison. The foundry was evidently now running well.

"We have poured five swivels to-day, all good, and cast four guns six pounders this week which I shall have bored next week," wrote the manager to the war commissioner a few miles away at Richmond. "I find John Onions makes his Guns to skin much better since he has made use of the sower cyder."

On October 21, Colonel John Fitzpatrick sent out his own wagons for six six-pounder guns cast for him, for which he paid in specie. In December, before the middle of the month, four more guns, all six-pounders, were wagoned into Richmond for Colonel Benjamin Harrison. And these were apparently the last guns delivered before the burning of the foundry.

When the Westham works had been running about eight months John Reveley computed that, given the raw materials, his facilities would permit him to cast annually there three hundred cannon and one hundred tons of shell, shot, and other castings, while with more artisans and sufficient materials he could cast nine hundred cannon a year and three hundred tons of additional castings. From the tone of his letter ten months later to Colonel Muter, Commissioner of War, it would appear that Reveley considered four guns cast in one week to be bored in the next constituted a good record. Accepting this as an average, and supposing that he did not lack proper pig iron and had sufficient workmen to cast and

*Documentary authority for every essential fact stated in this paper may be found in my unprinted manuscript. "The Iron Industry in Virginia before 1865 . . ." in the Radcliffe College Library, Cambridge, Massachusetts.

bore at the same time in his foundry and his boring mill, he could not have produced more than two hundred and eight guns in a year. The records show that he delivered forty-one guns between May 3 and December 12, 1780. And, as we have seen, some of these guns were evidently cast in 1779. He cast other guns, not bored, the number of which is indefinite, and he may have cast a few more that were bored. But it seems improbable that he could have produced more cannon annually than the Tredegar Iron Works made in 1861, even though the eighteenth century guns were much lighter and smaller than the iron guns of 1861. Probably the most extensive side of the Westham business lay in furnishing cannon ball, grape, and canister shot to the army in Virginia. Since tonnage is not systematically noted in the books it is impossible to compute the exact amount. But in this department Reveley may have come nearer to his estimate than he did in the manufacture of guns.

An Old Shot Tower in Virginia.

This old tower was used during the American Revolution and the Civil War. It overhangs the New River with a 175-foot drop where shot was poured.

By the present available records from fifty-five to sixty persons, white or colored, most of them doing casual work, were employed at the Westham works. This was a considerable force for that day. But to run eight air furnaces, a foundry, a boring mill, a smith's shop, to provide the "tradesmen" with shoes, to produce the castings for plantation, household, and technical use, and the ammunition and cannon listed in the extant account books, as well as to supply hands to John Ballendine to work on the canal, must have required labor of whom the record is lost.

Negroes were depended upon and the industrial system evidently resembled that used about seventy years later in the Tredegar and Armory rolling mills at Richmond, where a comparatively small number of skilled white workmen conducted operations with the aid of slaves trained in iron manufacture. Two of the nine white men on the tax list and two who do not appear there had charge of the castings done at Westham. One of the nine, at least, understood the art of boring. On December 29, 1780, James Calhoun is charged with the hire of negroes for sixty-four days in assisting to mould and cast cannon. A previous entry shows that on October 26, of the same year exactly sixty-four days earlier, six slaves, four of whom at least were state owned, began to work for James Calhoun, and yet there is no other entry to show that Calhoun took part in the casting and boring which went on at the foundry. One can only conclude that there are either lost account books in which the total number of hands and materials amount to more than that listed in the extant books, or that since the business was owned by the state, the government authorities furnished labor, pig iron, and coal, no account of which was required to be kept in John Reveley's books.

The lack of an adequate record of pig iron used at the works seems to support this conclusion. Present evidence shows that the Buckingham furnace furnished less than one hundred and ten tons and reveals only fifty tons delivered from any other source. Before Governor Henry left office in 1779 he contracted with David Ross to furnish two hundred and fifty tons of pig iron to the public foundry. On November 18, the proposition having been recommended to Governor Jefferson by the Board of War, Jefferson postponed its consideration until the assembly determined whether or not to ratify the contract with Penet and Company. The Penet scheme came to naught, and Ross's iron, already tested and approved by Reveley, was accepted. The exact amount sent to the foundry cannot be stated; but when the order was given for Colonel Harrison's guns and ammunitions, which Reveley on September 2, 1780, announced to be completed, it was requested that they be cast from Mr. Ross's iron. Between May 9, 1779, and December 12, 1780, the foundry purchased less than four tons of bar iron. But this may be a complete statement concerning bar iron, since casting, the main work of the foundry, was performed immediately from pig iron, and iron bar was apparently used solely in cutting spikes and nails.

The small amount of charcoal recorded probably sufficed for the smith's shop, as the air furnaces burned bituminous coal. From June 3, 1777, to July 6, 1778, the period when the works were under construction, James DuVall furnished the Westham foundry with 1,218 bushels of pit coal.

The next account of coal recorded is in the name of Samuel DuVall, Senior. Beginning May 9, 1779, he had by December 18 of that year, furnished the foundry 3,800 bushels of pit coal. On June 6, 1780, William DuVall sold to the foundry 2,045 bushels of pit coal. Here also the accounts prove to be incomplete. Even though this supply were adequate, the books contain no record of the coal delivered to the foundry by James DuVall on March 31, 1779, Samuel DuVall was paid on account £100, presumably for coal, of which, however, the books show no record.

Negro clothing and shoes as well as iron ware, cannon, and munitions were made at the foundry. The Board of Trade supplied woolens, oznaburgs (a coarse cotton cloth), and thread, and also provided stockings, woolen caps, and shoes. And nobody there, it would seem, lacked food and drink. Beef, bacon, wheat-flour, and corn. "Bear" by the barrel—better than sweet wine—rum, and even a flock of sheep are charged in the journal indiscriminately with iron supplies and products. The manager's house was at the foundry, and the laborers lived nearby in log huts. Women, also, with their children constituted a part of the group, since women were needed not merely to cook and wash, but possibly also to cut out and stitch clothing for the workmen. But even while abounding in the work of the Commonwealth, while supplied with coal and iron, comfortably housed, clothed, and fed, John Reveley and his artisans were forced to flee while their mills were cut down like a shadow.

Early on New Year's eve, 1780, Governor Jefferson received the news that twenty-seven enemy sail had entered the Virginia Capes. Dispatching General Nelson to the lower counties with authority to act upon his initiative until he should receive orders from Richmond, Jefferson also imparted the tidings to Major-General Baron Steuben, the commanding general of the district. But no more intelligence reaching the governor until January 2, it was not until that day that he ordered out the militia. Meanwhile under favorable wind and tide, the enemy moved up James River. Still Jefferson seems not to have divined that their objective was the government foundry beyond Richmond until the fleet anchored opposite the beautiful Georgian country house, Westover, hardly twenty-five miles overland from the little capital. Learning this at sunset on January 4, the governor knew that the enemy would disembark on the Richmond, not the Petersburg, side of the river.

If the astute Jefferson had been deceived, how startled must the busy company at the foundry have felt when wagon trains of arms and other military stores, hurried for safety out of Richmond, began to arrive at the foundry on the morning of January 4, 1781. After receiving the evening news, the executive speedily sent orders to move everything from the laboratory and from the magazine at the foundry to the town of Westham, a mile beyond and to turn all supplies over into Chesterfield at the crossing there; to work all night and to do the same at the Richmond ferry with whatever was left in the capital. It was past noon of the next day and the enemy almost in Richmond before folk left off moving back and forth over the broad river with their burdens. When the enemy was almost upon them three hundred stand of arms had to be thrown in the river. But fifteen tons of gun powder and ammunition and a number of arms and stores were already safely transported. As for the sunken arms the Virginians recovered them later. Jefferson who has been accused of incompetence and cowardice in the whole affair, passed here, there, and everywhere, giving orders, now at Westham, now at Manchester. Riding one horse till he dropped, the governor took another and having surveyed the enemy from across the river, proceeded to Baron Steuben's rendezvous and headquarters. But he had summoned the militia too late. Upon the stroke of one on January 5, the parricide Arnold, now a brigadier general, at the head of some fifteen hundred infantry and between fifty and one hundred and twenty horse, arrived in the little capital where he might do what he pleased without a protest. Here Arnold tarried. But not permitting Lieutenant Colonel Simcoe to halt, he hurried him at the head of a goodly force up the river to destroy the foundry. The country about Richmond must have been more thickly wooded in that day. No doubt, however, the surprising bluff rising precipitately out of a winding stretch of river bottom looked much as it does in 1927. Here, where a half finished canal wound about the base of the high hill, there loomed up partly at the foot, on the hillside, and upon the summit, the stacks and chimneys of eight furnaces, a boring mill, and moulding house, a magazine, the manager's house, and subsidiary buildings. One can fancy with what elation Simcoe viewed his prey—the rebel foundry which he with military terseness pronounced a very complete one.

Marks of the artisans, gone but a few hours, must have pervaded the foundry and shops while the swarming red coats rushed about, striking off the trunnions of the iron cannon scattered over the place, breaking up the quantity of small arms, and destroying the great host of military stores, so laboriously carted yesterday by the men from Richmond. But to dispose of the magazine without catastrophe to themselves was a weary task. A British artillery officer counseled that it should be destroyed and not blown up. Thus, for hours men under orders of their colonel toiled wearily up and down the cliffs to pour their burdens of powder into the canal. Then with torches lighted, probably from furnaces kindled by the American workmen, the British soldiers fired the various warehouses and mills, the magazine and Ballendine's dwelling. At last, turning their backs on this pillar of fire they marched the six miles to Richmond, through the winter night in which the sound of explosions boomed continuously like the cannon which the Westham foundry would never again make. Next day the whole force, after destroying the stores which remained in Richmond, returned to their ships.

"Within less," wrote Jefferson to the President of the Continental Congress, "than 48 hours from the time of their landing & 19 from our knowing their destination they had penetrated 33 miles, done the whole injury & retired."

Not at all paralyzed by the invasion, Jefferson, aided by the commissioner of war and Turner Southall, the leading commissioner of the fundry, immediately set about contriving to rebuild the works. Boring mill, magazine, and artisans' houses had been utterly destroyed. But only the roof of the foundry was burnt; chimneys and furnaces remained practically uninjured. By February 23, 1781, the commissioner of war had made satisfactory terms with a certain Chow to build a new boring mill and moulding

house. The commissioner, also, approved by the governor in council, arranged to procure considerable additional labor to carry on the war work which could be resumed as soon as the foundry roof should be completed. But for some reason restoration of the Westham works was given up. Cartridge making, however, was immediately recommenced at the Continental Laboratory. Captain Irish, the officer in charge, to whom the governor now turned over nineteen hands, probably ex-foundry men, to assist in making ammunition, had in stock, eleven weeks after the destruction of the Westham works, eighteen thousand cartridges and was turning out three thousand a day. But Jefferson feared that the supply of lead there would not "employ him much longer even at this slow rate," since the vein of the lead mine on which Virginia had long successfully depended, failed some weeks before.

The First Repeating Gun Built in America.

This gun, designed and manufactured by the Confederate Army, was not a success due to its tendency to discharge all six chambers at once. The entire gun crew was killed when the first shot was fired.

Private industry also performed its part in producing ordnance for the Revolution. Manufacturing and selling some form of iron in or on the edge of Tidewater, were David Holt, John Taylor of Neabsco, and James Hunter; in the Piedmont, David Ross, the unfortunate Ballendine, the Bear Garden furnace in Buckingham, and the Albemarle Iron Company; in the Valley, Miller in Augusta County, Zane in Frederick, Dirk Pennypacker in Page, and a group of gunmakers who in 1777 before the House of Delegates pleaded special aid for their factory. According to Jefferson the Virginian furnaces in 1781 were producing between four thousand and five thousand tons of pig iron and around eight hundred tons of iron bar. His statement, however, is probably only approximate.

Of these independent ironmasters, the Scotchman David Ross probably in the scope and importance of his production played a sturdy second to the Virginian James Hunter, the leading ironmaster of his day in Virginia. The Scotchman's establishment in Campbell County below the James included the Oxford furnace (which Jefferson said produced sixteen hundred tons of pig iron annually) and a forge and mills that manufactured iron bar, nail rods, shot and shell. Not only did David Ross pursue an active business in Virginia, but he essayed to supply the quartermaster's department of North Carolina. His works even excited the notice of the Continental government, so that Captain Daniel Joy offered to contract with him for ten and eight-inch sells and for twenty-four and eighteen-pound shot delivered at Westham at fifty pounds the ton, Pennsylvania currency—a greater price, declared the Continental agent, than had been yet given.

James Hunter belonged to a family of gentle birth who were also possessed of considerable wealth and land in Fredericksburg and in the countryside not far away. Before the Revolution and the rise of Hunter's iron works, one and possibly two James Hunters, other than the ironmaster, were successful merchants with headquarters in the Spotsylvania town or in King George County across the Rappahannock River.

The ironmaster, doubtless their kinsman, brought up in Fredericksburg, or in the neighborhood, must have been familiar from his youth with the successful Spotswood furnaces. Perhaps, long ago, tales of "the Governor" and his brilliant talk on the future of the iron business in Virginia had roused a boyish desire to emulate him. Young Hunter could also scarcely have failed to realize the convenience to the neighborhood of the Spotswood furnaces which supplied the town and great plantations with iron necessities. About the time, too, when he began to build his works, old grievances were soldifying against England;

possibly some day the colony would require home-made ordnance. The sympathetic official documents prompted by a sense of common injury now flew back and forth between the colonies, and introduced active intercourse. Statesmen and politicians breaking the journey at the falls of the Rappahannock, always an important point in stage coach days, must have talked over potential needs, and cited the thriving iron business being conducted in the more northerly colonies. When the planters in convention hastened to encourage iron manufactures, did people think of Spotswood?

To unwavering integrity Hunter united ability and some of Spotswood's energy. He was aided also by a manager whose industrial acumen seemed to anticipate nineteenth century experience. Thus, it is conceivable that, before the richer ores of the interior became available, these men might have attracted to the district skilled labor and bred a class of native artisans. In such manner, they might have created an industrial centre, immediately sensitive to the influence of the coming economic revolution. In 1781, Hunter possessed ample equipment and a good market for that day; iron ore mined as late as the nineteenth century lay nearby. Temporarily crippled by the abnormal currency, he appeared to need only mild but sustained legislative aid to give the manufacture of merchant iron a foothold in Virginia.

Model of the First Breech-loading Cannon.
This model, recently discovered in an attic in Northern Virginia, was presented to the Virginia Historical Society by Henry M. Chambers, grandson of the inventor. Some of its parts are similar to those used on guns of modern design. The inventor sold his patent for $5,000 and 2,000 acres of land in Texas.

Writing to the governor in 1781, beseeching military protection for Fredericksburg believed then to be menaced by the British, James Mercer, one of the eleven members of the late committee of safety of Virginia, and the son-in-law of Charles Dick, spoke of "the town and its appendage, Mr. Hunter's iron works." Rather does the little eighteenth century town appear to have been the appendage to the neighboring industrial group, which included a mill for making iron for army and navy, a second mill for fashioning arms, entrenching tools, and anchors, a third for slitting and plating iron, a fourth for producing wire, an article which the South did not manufacture in 1860, and finally, a steel furnace. But Mr. Mercer meant no disparagement. "I am sure," he continued, "I need not tell you"—which seems to imply that the importance of these mills was common talk—"that it is from Mr. Hunter's works that every camp kettle has been supplied for their Continental and all other troops employed in this state and to the southward this year past—that all the anchors for this state and Maryland and some for the Continent have been procured from the same works; that without these works we have no other resource for these articles, and that without the assistance of the Bar Iron made there, even the planters hereabouts and to the Southward of this place would not be able to make bread to eat." Then referring to that subsidiary factory to the Hunter works, the government arms manufactory, Mercer reminded the new governor that it was located in Fredericksburg, that there was no one spot in Virginia so generally useful as Fredericksburg in the current military operations, that fully one-third of all new lines held rendezvous there, and that the road of the continental armies led through the town.

Those were great days for Fredericksburg—days made great by the economic importance of the spot. And as one broods over the eighteenth century citizen's letter to the famous planter-republican, one forgets the town between Richmond and Washington as it exists today, whose claim to distinction lies in an historic citizenry and battles long ago. One sees a Fredericksburg on the banks of a broad highway up which now and then sails a graceful ship, bringing Maryland "pigs," gun scalps and German steel and carrying away within six months to Baltimore or to the southward, a thousand iron kettles, iron bars, tools for trench digging, and anchors for ships. One hears the clatter of troops, which must pass through this town from North to South and South to North; the clang of anvils as army wagons are repaired and limping horses shod; the loud talk of militia applying for arms, or of regular troops offering their old flint locks to be repaired; or of some magpie county lieutenant in the lobby damning the arms factory for a fault altogether his own; while with the mind's eye he sees it all too, even to the wagon loads of corn and fodder passing up the narrow streets to the commissary's from granaries of still fertile river bottoms.

At whatever date James Hunter entered the iron business, he probably began to expand his works shortly before or after August, 1775. In the following June he exhibited to the revolutionary convention a sample musket with bayonet, sheath, and steel ramrod of his manufacture which so pleased the legislators that they made the Hunter sample the standard for manufacture in the colony and ordered Hunter to produce during the next twelve months as many as he could at the rate of six pounds for each stand. Nevertheless, it was the quick brain of the ardent radical Patrick Henry that first realized the significance of Hunter's iron mills. Impressed by the man no less than by the "extent" and "vast importance" of his work, Governor Henry even before he carried the matter into the

assembly promised Hunter government aid. Hunter, himself, perhaps fearing that Mr. Henry's enthusiasm might cool and that both executive and legislature might come to look upon him as a mere Jock o' dreams, called upon his able manager, John Strode, to prepare a practical statement which would show how far the governor's expectations might be realized if the mill's capacity were increased.

The paper declared a three hundred foot gunshop absolutely necessary, but that the profitableness of this and other enlargement depended on an available supply of pig iron and on the government's attitude towards the works. Recruiting must be forbidden as also impressment of teams. Mr. Hunter must have the right to buy ore lands appraised by disinterested men and to erect furnaces at points most accessible to the ore. Workmen must be encouraged; contracts made at reasonable rates and for definite periods; and the ironmaster must be guaranteed adequate recompense should the closing of his factory through expediency leave on his hands unfinished government work. Maintain these stipulations and the able manager believed that expansion would justify itself to almost any extent.

On May 31, 1777, Governor Henry placed before the General Assembly a patriotic memorial from James Hunter, John Strode's paper, and a strong recommendation from the executive pen. Doubtless, like Henry, the legislature were impressed that Hunter asked for no pecuniary aid. At any rate, the assembly promptly passed an act that covered every stipulation which Strode laid down. Hunter lost no time in communicating with the Maryland branch of the English company still the owners of the Accokeek Mines in Stafford County, and they, conscious of their remoteness from Accokeek and a bit disdainful of the uninviting prospect there, readily disclaimed intention of reopening the mines. Thus by November, 1777, it is probable that James Hunter for the sum of five hundred pounds current money of Virginia and through the joint effort of five commissioners appointed to locate land for iron works and a jury of twelve disinterested men, had become owner of two hundred acres of land at the abandoned Accokeek Iron Works, including apparently the old furnace seat and the dam.

It is not known whether these mines, or other which he may have opened, proved adequate. In any event, no evidence of Hunter's lack of pig iron has come to light. Apparently, he successfully enlarged the works; otherwise they could hardly have come to form the chief dependence for iron supplies of Greene's and Gates' armies, as well as of the Commonwealth. During the summer of 1780 the Virginian ironmaster forwarded to General Gates sundry manufactures—possibly axes to hew a way through southern forests, tools to make passable mire-locked trails, and the private's companion—the indispensable iron camp kettle—to the amount of one hundred and thirty thousand pounds. In the following February, Governor Jefferson lightly requested that one thousand additional arms be immediately made ready for the separate use of the state. Hunter's reply that all possible dispatch would be used in executing the order, reveals something of the capacity of the works when we know that at that time they were busy casting kettles and axes for General Greene and performing other work for the Commonwealth. And it must not be overlooked that they also supplied iron, steel, and charcoal to the government factory.

The British grasped the importance of Hunter's works when they menaced Fredericksburg in February and again in June, 1781. On both occasions Governor Jefferson hurried General Weeden to protect them, and Weeden arrived in time.

By repealing the exemption act in 1780 the assembly repudiated their promise to Hunter and conclusively crippled his capacity. The draft demanded so many artisans that his small arms factory, an important department, was by February 1781 perforce discontinued. General Greene, lamenting the suspension of this work, testified to its potential capacity for general service to the country and offered to strip his army of every "artificer" that they might be utilized in the arms factory should it be revived. With a patriotism that is not without pathos, the ironmaster offered the governor the use of his building, and such tools as he had, if it might be decreed wiser that the state should carry on the arms manufactory rather than that it should continue "for the account and under the eye of an individual."

A month earlier he had endeavored to raise money by permitting the state already deeply in his debt to take over his stock of coarse woolens sufficient to clothe from one hundred and fifty to two hundred men. For these goods the state, appointing an inspector and appraiser, might pay him in tobacco at fifty pounds the hundredweight. In March the legislators attempted to make amends, and passing an act to exempt artisans employed in iron works, continued it until the war ended. But the evil had been done; the sword cutters and other skilled labor were locked in the army.

Later in the year the ironmaster seems to have assembled more workmen and to have dared to venture into considerable expense to make another addition and more repairs to his works. Upon the governor's order in October he was expeditiously turning out what were dubbed travelling forges. But the war was over after Yorktown, and "the public," eager to forward Mr. Hunter's project at the beginning of the Revolution, now would not even pay him the heavy debts due for services performed. Refused support of his works, this lofty patriot and most exemplary business man, having spent his own fortune in one of the most deranged periods in financial history, was forced for lack of funds to discharge all his workmen in December, 1781, and with words partly to this purpose, on April 23, 1782, to the Commissioner of War in answer to an order to repair arms, he makes his exit from the scene.

In less than a twelve-month the Fredericksburg arms factory, the Westham foundry, the Buckingham iron works, and Hunter's works had gone out of business. The collapse of what had seemed promising was due probably to many reasons, but the chief cause lay in an inflated currency. The Commonwealth's neglect after 1778 to stand behind the industry, which it had either created or to which it had lent aid, proceeded from impotence and probably checked an interest, which was by no means general in the community. Virginia gave what she had to the common cause—her arms, powder, and money. Between May, 1779, and July, 1780, her treasurer paid out to the Continental government nearly four and a half million pounds, or over thirteen and a half million dollars. The Congress continued to make requisitions, and on July 17 the state still owed a half million dollars and large quan-

tities of meat, flour, salt, short forage, and rum. The assembly passed acts to increase taxation and to borrow money; they set a specific tax on tobacco; but a serious cause of distress lay in the planters' inability to sell their great staple. When the Congress called on Virginia and North Carolina to recruit, remount, and equip Washington's and White's cavalry, Virginia, except to furnish 200 saddles, assumed the whole burden and spent between £600,000 and £700,000. In such ways the treasury was exhausted. Jefferson, governor during the major part of this period, encouraged the manufacture of iron yet was powerless to give the ironmasters adequate financial aid. Had there been no other cause, the tangled affairs of the Buckingham furnace to which the Westham foundry looked for pig iron would have been sufficient to turn the legislators from industrial experiment.

It should be recognized, however, that as long as ordnance was feverishly needed the manufacture continued. And not the least interesting side of Virginian iron industry of this period, and that which seemed to promise well for the future, lay in the supplies which the individual enterprises produced for their own wants, and in their trade with each other. John Reveley built the Westham air furnaces from bars and plates cast on the spot, while a certain John Clark supplied "patrons," for the cannon ball, grape shot, swivels, and wagon boxes cast at the foundry. The artisans at the Fredericksburg arms factory for greater dispatch made their own tools out of materials supplied from James Hunter's works, and though when the bay was clear of privateers Charles Dick might import gun scalps and German steel from Baltimore, he drew most of his materials from his neighbor. Hunter himself ordered and received from the Westham foundry for his forge 3 hammers, weighing each 500 pounds, and 2 rollers for his slitting mill, the combined weight of which was 1,500 pounds, while he sent nail rods and wire to Westham, and possibly produced a portion of the pig iron which his works consumed. In December, 1779, John Reveley borrowed James Brown from some Fredericksburg enterprise, to make drills and drill cannon at Westham; John Ballendine drew both iron and food supplies from the foundry which he supplied as far as he could with pig iron from his blast furnace built to feed the Westham air furnaces; the air furnaces erected with fire brick from the neighborhood were run by bituminous coal out of Henrico County pits; canoes freighted with coal went from Westham to the important state arsenal and shops upon Mount Independence at Point of Fork on James River, where wagons and gun carriages seem to have been made and repaired; David Ross boated pig iron, famous for its toughness, and a few iron bars and plates down the river to the foundry; Charles Dick produced 100 stand of arms a month; John Reveley cast at least 40 cannon a year with considerable ball, shot and plantation castings; and John Hunter manufactured axes and kettles by the thousand, anchors, tools, bar iron, bits, spurs, and curry combs and a large supply of muskets and guns. Thus notably for that day did the great Commonwealth in which the planting ideal dominated, utilize the brains, brawn, and skill of its citizens, its negro slaves, and its mineral wealth in manufacturing ordnance for the war of the American Revolution.

Types of Army Rifles Since 1789 on Exhibit

ADDED to the historical display at the entrance of the office of the Secretary of War, in the State, War and Navy Building, at Washington, is an exhibit showing each type of rifle and carbine used in the Army from 1789 to the present, the Department of War has recently announced.

The Departmental statement describes, in their essential features, the 16 rifles, which are displayed in a glass enclosed case.

The full text of the statement follows:

An interesting exhibit showing each type of rifle and carbine used in the Army, from the old smooth bore musket of 1795 up to and including the Springfield rifle in present use by the Army of the United States, has been arranged at the entrance to the office of the Secretary of War, State, War and Navy Building. The exhibit is composed of the following:

A smooth bore musket, caliber .70, the model used by the Army from 1795 to 1842.

A "Hall" breech loading rifle, caliber .54, used in the service from 1825 to 1840.

A musket, caliber .69, model 1842.

A rifled musket, muzzle loading, caliber .58, model 1862.

A "Remington" rifled musket, caliber .69, model 1855.

A rifled musket, muzzle loading, caliber .58, used in 1863.

A converted breech loading rifle, caliber .59, model 1865.

A "Spencer" breech loading magazine carbine, caliber .50, used by the cavalry in 1865.

A "Sharps" rifled carbine .52, model 1863.

The above two models of carbines were used by our cavalry during the Indian wars.

A United States rifle, model 1863.

A United States rifle, caliber .50, model 1870.

A "Remington" rifle, caliber .50, model 1870.

A United States rifle, caliber .45, which was the standard rifle of the Army from 1873 to 1893. This rifle was the infantry arm during the later Indian wars and was also the weapon with which most of the Volunteer and National Guard troops of the Spanish-American war were armed.

A United States rifle, caliber .30, model 1898. This is otherwise known as the "Krag" rifle. It was the first high-velocity, small-bore arm, using metal cased bullets, adopted by the United States Army. It was used to some extent in Cuba and was quite extensively used in the Philippines.

A United States rifle, caliber .30, model 1903. This rifle is the one now in use by the United States Army and is conceded to be the most accurate and best finished service rifle in use by any army. It was in use during the World War.

A United States rifle, caliber .30, model 1917. This model is also known as the "Enfield" rifle and is the model manufactured in large quantities during the World War and used by a majority of the troops engaged over-seas.

Editorial

Ten Years After: A Reminder

SIR PHILIP GIBBS, famous British litterateur, brought forth in 1924 a very remarkable volume under the above title. That year, 1924, was the tenth anniversary of the entry of Great Britain into the World War. The present year and the present month mark the passage of ten years since that memorable date in April, 1917, when our war President declared that "the day has come when America is privileged to spend her blood and her might for the principles that gave her birth and happiness and the peace that she has treasured."

On this our anniversary, it may not be inappropriate to ask thinking men to stop for a brief moment and take stock. How do we stand and how are we faring as "the war to end war" retreats beyond the first decade on its march into the past? In our answer we must share, in a general sense, with all others the applicability of Gibbs' remarks as to the vast change this short period has wrought:

"Ten years ago—not much in historical time, not a great span in the life of an individual, but so long, because of what has happened, that only by an immense effort of imagination can one's mind leap the gap between that time and this. One has to think back to another world in order to see again that year 1914 before the drums of war began to beat. It is a different world now, greatly changed, in the mental outlook of men and women, in the frontiers of the soul as well as the frontiers of nations. Dynasties have fallen, kings are in exile, the political maps have been redrawn, new nations have come into being, old nations have lost their pride and their place. And yet that is nothing to what has happened in the minds of men and women. Old habits of thought have been smashed; old securities, traditions, obediences, convictions, lie in wreckage, and unlike the ruins of the war itself, will never be restored."

It is not becoming in this place to moralize on things in general and their change for better or worse. But it is fitting, we believe, to contemplate for a moment the changes that have come about in the past ten years in our own field, that of adequate munitions preparedness.

For simplicity, possibly a division of this decade into its three principal periods might be advisable. First, there is the period of our participation in the war and the years immediately following; second, our adoption of the National Defense Act of 1920 and the years immediately following; third, today—"ten years after."

I

IT should be, and is, a source of well-founded pride to recount the marvelous feats of accomplishment of our nation during the war days. Men were trained and sent overseas in numbers and kind rivalling the crusaders of old. The achievements of our flag sustained by our valiant troops will be recounted in ages to come wherever courage, patriotism and sacrifice are looked upon as virtues. At home the effort to equip and transport our men was stupendous. The country became one vast arsenal producing the sinews of war. Guns and ammunition—*ordnance*—were the cry of the day, and American industry, led by courageous leaders, put its shoulder to the wheel in an heroic effort to make "force without stint or limit" a reality. Eight billion dollars were expended on ordnance during the period. That may be some indication of our munitions effort—but what did we accomplish?

Turn to the Final Report of General Pershing as Commander-in-Chief, American Expeditionary Forces—"Our entry into the war found us with few of the auxiliaries necessary for its conduct in the modern sense. The task of the Ordnance Department in supplying artillery was especially difficult. In order to meet our requirements as rapidly as possible we accepted the offer of the French Government to supply us with the artillery equipment of 75's, 155-mm. howitzers and 155 G. P. F. guns from their own factories for 30 divisions. The wisdom of this course was fully demonstrated by the fact that, *although we soon began the manufacture of these classes of guns at home, there were no guns of American manufacture of the calibers mentioned on our front at the date of the Armistice.* The only guns of these types produced at home which reached France before the cessation of hostilities were one hundred and nine 75-mm. guns. In addition, twenty-four 8-inch howitzers from the United States reached our front and were in use when the Armistice was signed. Eight 14-inch Naval guns of American manufacture were set up on railroad mounts, and most of these were successfully employed on the Meuse-Argonne front under the efficient direction of Admiral Plunkett of the Navy."

And yet "guns at the front" are the real measure of our success in this respect. Guns being forged at a feverish rate in our great steel plants availed us nothing, ammunition being machined in our gigantic factories availed us nothing, explosives being produced in our huge chemical plants availed us nothing. The truth is we had been asleep. We awoke with a start, we converted our tremendous peacetime facilities into veritable arsenals, we spent eight billion dollars in the process but "there were no guns of American manufacture of the calibers mentioned on our front at the date of the Armistice." And this not for lack of energy, not for lack of ability, not for lack of desire, not for lack of resources—mental and physical, *but solely for lack of time.*

Benedict Crowell, Director of Munitions during the World War, and Capt. R. F. Wilson, in one of their volumes of the series "How America Went to War" epitomize the situation in this wise: "The clue may be found in the story of the would-be traveller who, bag in

hand, dashed through the railroad station of a country town and then on down the track in a vain effort to overtake a passenger train which had just pulled out. As he returned, crest fallen, a lounger said to him, 'Well, you didn't run fast enough, did you?' 'Yes,' he replied, 'I ran fast enough. The trouble is I didn't start soon enough.'

And that was just the trouble with our war industry: when it got fairly started, it became something entirely creditable to the greatness of American industry; and the world had never seen progress so rapid, on a scale of such splendor—but it started at least half a year too late!"

II

WITH the Armistice came the aftermath and that fevered state born of cruel experience. An era of petty partisanship dawned. Sincere effort was branded with the stigma of "profiteer," unfounded criticism was rife, even sterling reputation was jeopardized. The reaction that follows all fever had set in, it ran its course, and, thank God, was soon replaced by healthy constructive cooperation. Thinking men saw the need and form of the remedy—a few gave of their time and effort to make that remedy a reality.

The National Defense Act of 1920, our first and only mandate of real preparedness, was written into our organic law. Properly executed it is a piece of real statecraft. It recognizes the importance of elements that in the past were national blind spots. It provides for trained man power and it provides for trained munitions power, share and share alike. It recognizes the need of the reserve soldier to supplement our tiny regular establishment; it recognizes the need of the reserve factory to supplement our few regular arsenals. It aims, without undue burden on the pursuits of peace, to take time by the forelock. It welds the entire national defense structure into a homogeneous mass easy of manipulation and always *ready*. It endeavors to prevent the necessity for any future commander of our forces reporting "there were no guns of American manufacture of the calibers mentioned on our front."

In carrying into immediate effect the provisions of the National Defense Act we were not quite as diligent as we might have been. A feeling of false security aided and abetted by a doctrine of false economy retarded the execution of even the fundamental provisions of the act. That hydra-headed monster—the paid pacifist—did effective work aimed at our system of military training in the schools. The enemy within our gates saw to it that there were still unconscientious believers in inadequate defense. Our Army was allowed to dwindle to the point of absurdity. Despite our wealth we housed our officers and men in hovels and allowed the soldier a ration of a paltry 30 cents a day. In the field of ordnance we were obliged to stand by as our stocks of war reserve supplies deteriorated before our very eyes—and a war reserve is the keystone of our new defense policy. We developed new guns, new ammunition, new tanks, new equipment, all far superior to the old but for lack of the wherewith we were unable to produce them in even a limited quantity to determine their suitability for use. Proponents of adequate defense knew by stark experience the folly of such conditions. To be sure, voices here and there were raised in appeal, even in protest, but they were voices crying in the wilderness.

For all that there was a steady quiet undercurrent of opinion that would not down. Thinking men saw that the pendulum must eventually swing in equilibrium and that a true balance must soon be attained.

III

TODAY—ten years after. The nation seems to have learned its lesson. National defense in all its phases seems to be coming into its own. Opinion has changed—not only the opinion of the man in the street but even the opinion of men in high place. They have been *thinking* and when one takes time to think the light is usually seen.

Industrial Preparedness, unheard of a generation ago, is now a dogma of our defense creed. Hand in hand man power and munitions power stand upon a level. The man behind the man behind the gun is recognized. Our Ordnance Department is carrying on its important work in great fashion. Industry is cooperating as only American industry can. Now there is time and with time, cooperation and fair play, mistakes of the past are easily overcome. Men are thinking.

And so long as they think it is probable that conditions will continue to improve—for there is yet room for tremendous improvement. Improvement has only begun. In the category of ordnance our ability to design new weapons is far ahead of the probability of having enough of them to test. That is a serious situation. A program over a definite number of years with funds assured will remedy it. Provision has been made for some replacement of our deteriorating ammunition reserve. That replacement should be guaranteed, it should be steady and constant. The proportion of trained Regular Army personnel qualified to acquaint industry with our munitions requirements in war is in ridiculous ratio to the number of officers assigned to the training of reserve men. Indications are that a better adjustment in this respect will soon be forthcoming. These are some of the more important matters that claim immediate attention. There are many others of less concern. Faith in the ability and wisdom of our present leaders—civilian and military—prompts the assurance that with major problems approaching solution less important requirements will be handled expeditiously.

Ten years after—and there is cause for much pardonable pride on the part of preparedness advocates who have helped ordnance come into its own. For that pride is based upon the knowledge that progress toward real national defense has been made and that peace is just that much more secure—peace for the unmolested progress of the arts, for the keener enjoyment of the fruits of labor, for a better development of our homeland, for an uninterrupted path in the enjoyment of life, liberty and the pursuit of happiness—peace based on right and sustained by cooperation.

"The tumult and the shouting dies,
The captains and the kings depart;
Still stands Thine ancient sacrifice,—
An humble and a contrite heart.
Lord God of Hosts, be with us yet,
Lest we forget,—lest we forget!"

Ordnance News in Pictures

Polish Tank Carries Gas

A Polish tank equipped with gas containers and projectors is said to have been exhibited during recent Army maneuvers at Warsaw, Poland.

General Joyes Inspects Ordnance Equipment

Brig. Gen. John W. Joyes, Assistant to the Chief of Ordnance and head of Ordnance Field Service, examining a field gun during a recent tour of inspection through the New England states.

A Gun of Rare Composition

"Custer Gun" exhibited by Joseph Trax, Civil War veteran of Newcastle, Pa., who claims that among other things used in casting the gun were two brass door keys to Ford's Theatre, Washington, where President Lincoln was shot; three gold Army dollars; a brass lock from Harper's Ferry Arsenal, scene of John Brown's Raid, and various spurs, buttons, badges, drum ribs, bullets, shell cases, flag spears and even a cow bell!

Professional

Professor Moulton's "New Methods in Exterior Ballistics" Arouses Comment

A REVIEW of F. R. Moulton's "New Methods in Exterior Ballistics," written by one of Professor Moulton's former students, Capt. James L. Guion, and published in the September-October, 1926, number of ARMY ORDNANCE, does adequate justice to its substantial merits. In general I agree with Captain Guion's estimate of the first chapters of the book. It should be noted, however, that the almost complete absence of references to earlier work conceals the debt the author is under to other ballisticians for having proposed and solved the major problems of ballistics, although, of course, Moulton's methods of solution surpass in elegance and simplicity those previously given. However, this independence of previous investigators has its advantages for the student of ballistics because it enables him to avoid reading the details of what are now obsolete methods.

In the last chapter the problem of the motion of a rotating projectile is discussed. In this case, however, the independence of previous investigators leads to results that are less fortunate.

Disregarding the experimental and theoretical results of Fowler and his associates,* the author assumes that the cross-wind force, i. e., the force perpendicular to the trajectory resulting from the oblique presentation of the projectile, is negligible. Now Fowler in his paper shows quite conclusively that this force exists and measures it approximately. The results of Fowler have been confirmed in the experiments conducted under my direction at Aberdeen Proving Ground. The force is by no means negligible. In fact, the contribution of the cross-wind force to the overturning couple (on which the stability depends) is about ten times the contribution of the head resistance. As a consequence of this contrary to the fact assumption, the results and formulae of the last chapter are for many purposes inapplicable to the analysis of jump card experiments and if so applied would lead to incorrect results regarding the position of the center of pressure and damping.

In regard to damping especially, the neglect of the cross-wind force makes it impossible to reconcile the observed facts with the theory. Indeed the author admits on page 252 that, "The fact that in rectilinear motion the damping forces do not always bring the axis of the projectile into the line of its translatory motion, and that in general the curvature of the trajectory plays an important role in the trailing of projectiles, has been the source of serious difficulty in making a general demonstration of the observed fact that well-designed projectiles remain nearly nose on throughout their flight."

Moulton proves on his assumption that of the two types of motion (called by Fowler "step-up" and "step-down"), the oscillations of one type (step-up) are damped out while the oscillations of the other type (step-down) tend to increase. He fails to bring out the fact that on his assumptions the oscillations would always change from the step-up type to the step-down and thus, although on Moulton's assumptions there would in certain cases be initially a damping of the yaw, yet even in these cases the type of motion would soon change to that for which on Moulton's assumptions there is negative damping, i. e., the oscillation would increase in amplitude.

Of course, as stated above, the introduction of the cross-wind force changes all this and makes it possible to account for the observed damping in a satisfactory manner, as has been done by Fowler and his associates.

It is regrettable that Moulton overlooked this very important element of the force system because its omission constitutes the only important respect in which the book fails to give an adequate treatment of its subject. It is to be hoped that the author will revise the last chapter and so make this chapter as well as the others an outstanding contribution to exterior ballistic theory.

R. H. KENT.

IN September, there appeared, from the press of the University of Chicago, F. R. Moulton's "New Methods in Exterior Ballistics." Let me state emphatically at this point that I yield to no one in my respect, admiration and gratitude for the contribution which Professor Moulton made to the science of gunnery when, as a Major of Ordnance in 1918, he reverted to first principles and laid the foundation for a new Ballistics adequate to deal with the problems of modern matériel.

The fundamental differential equations of motion of a projectile had been known for several centuries; but, up to Professor Moulton's contribution to the science of Ballistics, progress in that science had consisted in devising approximate algebraic expressions whereby to wrench these equations into soluble form.

In spite of constant improvement of these approximations, they could not keep pace with the rapid development of modern artillery; so that finally Professor Moulton showed how the equations of motion could be integrated in their original form, by means of numerical integration.

Thus he laid the cornerstone for an entirely new science of ballistics, and accordingly no one is better qualified

*Phil. Trans. Roy. Soc. of London, Series A, Vol. 221, pp. 295-387. Aerodynamics of a Spinning Shell by Fowler, Gallop, Lock and Richmond.

Phil. Trans. Roy. Soc. of London, Series A, Vol. 222, pp. 227-247. The Aerodynamics of a Spinning Shell Part II by Fowler and Lock.

than he to recount the pioneer steps of this new science. As such an account, his book is an invaluable addition to the history of mathematical physics.

It is no discredit to Morse and Bell that the telegraph and telephone of today have progressed beyond the point to which they developed it; in fact, this progress is largely due to the excellence of their ground work. It is no discredit to Moulton that the same is true of Ballistics and him.

His book, in spite of the word "New" in its title, uses the symbology of 1918 and treats of the methods of 1918, but these methods were so new and revolutionary when devised, that we can readily excuse his poetic license in calling them new today.

Thus far, the situation requires merely the pointing out of a few of the more marked modern improvements.

But, in ARMY ORDNANCE for September-October, 1926, there appears a long and detailed review by Capt. James L. Guion, one of the officers detailed by the War Department to study Ballistics under Professor Moulton. In this review Captain Guion thus characterizes the 1918 ~~material~~ of the Moulton book:

"His complete theory, which leaves no questions unanswered from either the theoretical or practical point of view, he has now given us in his book. . . . . Although it is probable that the theories set forth in this book will be adequate for all practical requirements for a long time to come, Professor Moulton concludes his treatise by indicating how the methods that he has developed are capable of being easily extended to meet any needs that may ever arise."

Yet, at the date that this was written by Captain Guion (an official War Department student, who presumably is supposed to have been studying the very latest developments in Ballistics), most of the Moulton methods of which he speaks had been entirely superseded for over five years, in many instances by methods which are not in any sense an extension of Moulton's.

May I take the space to outline some of the changes. The basic methods of computing standard trajectories, though essentially the same, have been improved in many important details. In 1919 the Bliss-Franklin-Gronwall differential corrections were substituted for the Moulton; yet the book merely mentions the *Bliss* part of this development and says that it is limited in its application, which statement time has demonstrated to be untrue; and Captain Guion's review does not refer to this development at all. In 1920 the fundamental coordinate system was changed, the Ingalls-Siacci tangent datum-plane being abolished, and the actual curved surface of the earth being used for the xz "plane"; yet Professor Moulton's book still clings to the tangent plane, and gives a "correction" for curvature of the earth. His treatment of weighting-factors entirely disregards Ritt's weighting-factor curves for zero elevation, and the mean curves which have been officially adopted by the services. His chapter on the spinning shell bears very little resemblance to the complete theory which Captain Kent is working out at Aberdeen.

Last, but not least, the book employs throughout symbols which were officially discarded in 1919, as a result of a three-cornered correspondence between the Technical Staff, the Ordnance School and the Ballistic Section of the Proving Ground, and also overlooks the recent adoption of a left-handed z-axis and a north zero of azimuths. These matters of symbology and convention are not mere optional details. They become serious when involved in the teaching of officers whose practical work and further research must be done under totally different symbols and conventions. The two changes of convention alone have already cost me a great many hours of pinstaking labor in changing the algebraic signs throughout my copy of Moulton's book, in order to render that book usable in my own work.

W. D. Document No. 1951, published in 1921, is admittedly obsolete; yet it is considerably more up-to-date than Moulton's "New Methods," published in September, 1926. The methods described in Moulton are the same as those described in the article in Vol. 30 of the Encyclopedia Brittanica, presumably written before W. D. 1051.

I can only hope that Captain Guion was carried away by enthusiasm for his teacher, who is a charming and instructive individual, and that the book does not represent what is being taught to our Army officers as modern Ballistics.

The material in the book is very valuable historically, and should be included in such a course as that given Captain Guion. But it should be taught in the symbols and conventions of modern usage, in order to render it of practicable application to what is going on at Aberdeen; and, even if post-war developments are not included, the student should be made to understand clearly that the book covers merely the pioneer steps of modern Ballistics rather than its present-day status.

ROGER SHERMAN HOAR,
Maj., Ord. Res., U. S. A.

Test of Chromium Plating

DURING the recent overhaul of several thousand U. S. rifles, cal. .30, Model 1903, returned from the using services, it was noted that a large percentage of the bolts had the rear of the slotted lug badly deformed on the face which strikes the cut-off on opening. There were no nickel steel bolts among those returned from the service, so the question arose as to whether nickel steel would upset from continued impact in the same manner as carbon steel bolts. Several articles having appeared in technical magazines on chromium plating, indicated that such plating might furnish a hard corrosion-resistant case on bolts, which would noticeably increase their resistance to deformation.

Through the courtesy of the Udylite Process Company of Kokomo, Indiana, four nickel steel bolts were given a chromium plate of approximately .0002-inch thickness.

(a) These plated bolts and four unplated nickel steel bolts were operated in rifles by opening and closing 10,750 times each. Special attention was given to bringing the bolt back smartly against the cut-off. The average wear on the slotted lug at the face where the cut-off struck was .0013 + for the plated bolts and .0013 for the unplated bolts. The average wear on the rest of the slotted lug was .0008-inch for the plated bolts and the same for the unplated bolts. The average wear on the

other locking lug was .00065-inch for the plated bolts and .0007-inch for the unplated bolts.

(b) Each bolt was then placed in a rifle, which was fired ten times at a pressure of 70,000 lbs. per sq. in. The average increase in head space for the plated bolts was .000775, and for the unplated bolts .000825. Measurements were taken in a bolt gage and are independent of the increase in headspace due to deformation of receiver.

(c) Each bolt was then placed in a steam cabinet ordinarly used in rusting for the browning process, together with four worn parkerized bolts, and exposed to steam for sixty hours. The unplated bolts were covered with a film of rust at the end of this time, while the amount of rusting was insignificant on either the parkerized or plated bolts. In both cases, similar spots were noted where the protective coating had been worn off.

From the above, it was concluded: (a) That chromium plating did not materially increase the resistance to wear or deformation. (b) That chromium plating was not superior to parkerizing as a protection against corrosion. (c) That nickel steel bolts are exceedingly tough and resistant to wear and impact stresses received during use in the service rifle.

JAMES KIRK,
Major, Ord. Dept., U. S. A.

Du Pont Eliminates Nitroglycerin Powders

THE elimination of Ballistite, the last of the nitroglycerin powders made by the E. I du Pont de Nemours & Company, has just been announced. In connection with this radical change, there has been issued a highly informative booklet of 64 pages on the subject of smokeless rifle and pistol powders. The author is Wallace H. Coxe, Ballistic Engineer at the Brandywine Laboratory, Smokeless Powder Department, of the du Pont Company.

Concerning the rifle and pistol powders now made by du Pont, Mr. Coxe states: "There is no nitroglycerin in any of the du Pont military rifle, sporting rifle, or pistol powders. All du Pont rifle and pistol powders are nitrocellulose powders.

"Nitroglycerin powders are double base powders and contain both nitrocellulose and nitroglycerin. The term nitroglycerin, while inexact, is used for convenience in describing this double base type of powder. Single base powders made of pure nitrocellulose are termed nitrocellulose powders. Since both types of powders are capable of developing the same ballistics, there are other important characteristics to be considered to make clear the reasons which influenced the du Pont Company to concentrate on the pure nitrocellulose type of powder. The most important characteristics are the following:

"(1) Nitrocellulose powders have a lower temperature of combustion than nitroglycerin powders and, consequently, are less erosive.

"(2) Nitrocellulose powders are practically unaffected by changes in temperature, whereas nitroglycerin powders are seriously affected.

"(3) Nitrocellulose powders are equally if not more stable than nitroglycerin powders.

"(4) Nitrocellulose powders give the longest accuracy life to a rifle barrel.

"(5) Nitrocellulose powders of modern manufacture are practically moisture-proof within normal range of atmospheric conditions.

"(6) Nitrocellulose powders of the progressive-burning type are the only powders capable of delivering extremely high velocities within normal pressure limits and without ruining the barrel.

"The du Pont Company reached these conclusions," says Mr. Coxe, "after extensive experience with both types of powders and that the conclusions are warranted is borne out by the experience of the United States Government as well as that of foreign governments."

Under the heading, "Military Rifle Powders," the writer discusses erosion, temperature, stability, hygroscopicity, storage of powder and kindred subjects. Part 2 is devoted to rifles, revolvers and pistols. The several divisions of the topic are barrel steel, short vs. long barrels, breech block and bolt, pressure limits for rifles, provisional and definitive proof, pressure limits for brass cases, smooth bores and cap and ball guns, Schuetzen rifles, special rifles, pressure gages, cleaning the rifle, metal fouling and leading.

"Components," Part 3, is divided as follows: Shells, expansion of shells, bullets, primers, paint for targets. Much valuable information is presented under the several divisions of the general topic.

The discussion of "Ballistic Data," which constitutes Part 4, delves deeply into the technicalities of this important subject, but, as handled by Mr. Coxe, every point is made clear even to the layman, though without taking away in the least from the interest with which it will be read by the expert.

Though Mr. Coxe explains: "It is obviously impractical to list all the books dealing with the science of ballistics in a small booklet," the list he gives is both representative and valuable, requiring more than two pages to cover the subject.

Pack Howitzers to Be Given Service Test

THE War Department has authorized a service test of the first battery of the 75-mm. pack howitzer developed and manufactured by the Ordnance Department. The test is to consist of a 500-mile practice march beginning about the middle of April this year. The battery will accompany the Fourth Field Artillery on its march from Fort McIntosh, Laredo, Texas, to Camp Stanley, near San Antonio, Texas, a distance of 180 miles, and there participate in maneuvers of the Second Division. While at Camp Stanley firing tests with the new matériel will be conducted, after completion of which the battery will return overland to Fort McIntosh.

The design of a new type of pack howitzer to meet the requirements of the Caliber Board program was inaugurated shortly after the World War and two models were constructed in 1920. The range requirement was placed at 5,000 yards. Later it was decided that a greater range was necessary and the present units were constructed to meet this specification. The new howitzer in firing position weighs 1,270 pounds; it provides for a total movement in elevation from 5 degrees to plus 45 degrees and a total traverse of five degrees.

Personnel

Ordnance Reserve Officer Training Courses

TRAINING courses for Ordnance Reserve Officers will be conducted at Watertown, Watervliet, Frankford, Picatinny, Benicia Arsenals and Springfield Armory from May 15th to 29th, 1927. The course at each arsenal will be particularly appropriate for officers assigned to the arsenal and for officers assigned to the various district offices whose duties require a knowledge of the inspection or manufacture of any of the matériel which is manufactured at the arsenal.

Training courses for officers assigned to Field Service, either in Washington or at one of the Field Service arsenals or depots, will be given either at a depot or in Washington, at such times as may be most convenient.

Basic training courses for Ordnance Reserve Officers will be conducted at Rock Island Arsenal from July 10th to 24th, and at Aberdeen Proving Ground from July 31st to August 14th. An officer will not be given the basic training course more than once, irrespective of the establishment at which he received training. However, an officer assigned to Rock Island Arsenal or Aberdeen Proving Ground may be given advanced training during the period of the basic training course.

Officers who have not completed their basic training are eligible for training either at Aberdeen Proving Ground or Rock Island Arsenal. The place of training will be that which is nearest to the officer's home. Applications for this training should be submitted to places of assignment so that they may be forwarded to Washington and received in the Office of the Chief of Ordnance not later than June 1st. At that time action will be taken on all applications which have been received. Applications which may be received after that date will be acted upon in the order in which received, but no application will be favorably considered unless received at least ten days prior to the beginning of the training for which application is made.

Training of officers assigned to service with troops is entirely under the jurisdiction of the Corps Area Commander and applications should be forwarded to him.

Cincinnati Post, A. O. A., Holds Annual Meeting

THE Cincinnati Post of the Army Ordnance Association held its annual meeting on January 20, 1927, at the Cincinnati Club, Cincinnati, Ohio. The evening's program began with dinner at 6:30 at the Club, at which Major B. O. Lewis, Ord. Dept., U. S. A., Office of the Chief of Ordnance, and speaker of the evening, was a guest.

After the dinner the following officers were inaugurated: President (one year): Mr. J. Wallace Carrel; vice-president (one year): Lt. Col. A. H. Pugh, Jr., Ord. Res. Directors (2 years): Col. C. L. Harrison, Ord. Res.; Frederick W. Hinkle, Edward B. Danson, Capt. H. L. Campbell, Ord. Dept., U. S. A. Director to represent Cincinnati Post in the Army Ordnance Association: Caspar H. Rowe.

At 8 P. M. the meeting adjourned to the rooms of the Engineers' Club, near by, where the local organizations of the American Society of Mechanical Engineers and the Army Ordnance Association, and members of the Engineers' Club of Cincinnati met jointly. Major Lewis addressed the joint session on "Modern Artillery." The lecture, which was illustrated by lantern slides and motion pictures, told the story of the remarkable progress which has been made in the development of guns, howitzers and artillery carriages since the World War. This meeting was well attended and was very successful in every way.

Mr. Edward B. Danson, who was inaugurated at the annual meeting as a director of Cincinnati Post for two years, died February 1, 1927, after a short illness.

Born in England 65 years ago, Mr. Danson came to America when a young man and soon made his way to leadership in the industrial world. For the past 25 years he was president of the Kemper-Thomas Company of Cincinnati. In his community he was a leader in business and civic affairs. During the World War he led to success practically every Liberty Loan and Red Cross drive.

His loss is deeply regretted by the Cincinnati Post, where his absence as a member of the board will be felt most keenly.

Washington Post, A. O. A., Hears E. P. Warner, Assistant Secretary of the Navy for Aeronautics

AT the invitation of the Washington Section, American Society of Mechanical Engineers, the Washington Post, Army Ordnance Association, participated in the meeting of the former organization, March 3, 1928. The meeting, which was preceded by dinner, was held at the Cosmos Club, Washington.

Hon. Edward P. Warner, Assistant Secretary of the Navy for Aeronautics, was the principal speaker. He addressed the joint gathering on "The Design and Supply of Naval Aviation Equipment." As the subject pertains to both aeronautics and national defense, and in view of the eminent authority of the speaker, the meeting was well attended. The address was followed by interesting discussion.

New York Post, A. O. A., Will Hold Annual Meeting

THE annual meeting and dinner of the New York Post, Army Ordnance Association, will be held at the Engineers' Club, 32 West Fortieth Street, New York City, Wednesday, April 6, 1927, at 7 P. M. Maj. Gen. James H. McRae has accepted an invitation of the Post to be present and all members of the Post are looking forward to welcoming the new commander of the Second Corps Area.

Major Rayeroft Walsh will address the meeting on his recent trip through Nicaragua and other Central American countries illustrating his talk with lantern slides.

A. S. M. E. to Visit West Point

WITH the cooperation of Hon. Dwight F. Davis, Secretary of War, and Brig. Gen. Mereh B. Stewart, Superintendent of the United States Military Academy, the American Society of Mechanical Engineers is planning to visit West Point on Thursday, May 12, 1927, to witness a special program of exercises and drills by the Corps of Cadets. In making this visit it is planned not only to enjoy an unsually interesting day but also to make manifest the interest of engineers, chemists and technicians in national defense, particularly its industrial phases. Members of the Army Ordnance Association have been invited to participate in the visit. (See announcement, page 365.)

Ballistic Research at Marquette University

MARQUETTE UNIVERSITY, of Milwaukee, Wisconsin, has instituted a research group of ballistics, under the auspices of the College of Applied Science and Engineering.

This group meets at the Engineering Building at 1200 Sycamore Street every Thursday at 5:30 P. M. After a brief survey of the Siacci-Ingalls System, the group is now studying with great care and detail the entire Moulton-Bliss-Gronwall-Franklin-Hoar System. Modern methods are to be subjected to critical scrutiny, all doubtful points being thoroughly tested, and all possibilities of improvement investigated. The War Department is cooperating by furnishing the necessary official texts. A summary of each conference is written up and blue-printed for the members.

The group includes:

Joseph J. Arnaud, patent assistant of Bucyrus Company, formerly master computer of the Technical Staff, Ordnance Department, and later of the Bureau of Standards.

Major R. G. Chamberlin, C. A. Res., instructor in mathematics at the Washington High School, Milwaukee.

Major A. W. Draves, Ord. Res., Vice-President of the Draves Corporation; formerly assistant professor of engineering at U. S. Military Academy, West Point; and later assistant to Col. Alston Hamilton in special ballistic work.

Lt. Col. Frank C. French, Eng. Res., dean of engineering at Marquette University.

George M. Harner, instructor in mathematics, Marquette University.

Major Roger Sherman Hoar, Ord. Res., assistant to the secretary, Bucyrus Company; former senior instructor in ballistics, Ordnance School of Application; author of "A Course in Exterior Ballistics," W. D. Doc. No. 1051.

Peter Luteyn, instructor in mathematics, Marquette University.

Capt. Emory D. Roberts, Eng. Res., assistant professor of civil engineering, Marquette University.

First Lieut. Wm. E. Roth, 120th F. A., Wisconsin National Guard; instructor in mathematics, University of Wisconsin.

F. Carl Ruhloff, patent engineer, Bucyrus Company, Milwaukee, Wis.

John E. Schoen, instructor in mechanical and chemical engineering, Marquette University.

A. A. Sperling, assistant professor of mathematics, University of Wisconsin.

Major Gunther Lectures on Ballistics

MAJ. CHARLES O. GUNTHER, Ord. Res., a member of the faculty of Stevens Institute of Technology, Hoboken, N. J., gave the last of a series of special lectures at the Institute, March 16, 1927. His subject was "Some Experiments in Ballistics."

The lecture, which was illustrated, included a description of the development of guns and also outlined experiments performed by the Ordnance Department, U. S. Army, to determine gun barrel pressures, velocity of projectiles and gun recoil. Major Gunther was graduated from Stevens Tech in 1900. After graduation he became instructor in mathematics, and later assistant professor and professor.

Recently Commissioned Ordnance Reserve Officers

THE following reserve officers have accepted commissions since the last issue of ARMY ORDNANCE:

Col. Harry J. Scullin, Ord. Res.,
6700 Manchester Ave., St. Louis, Mo.

Lieut. Col. Richard E. Cotton, Ord. Res.,
1795 Lincoln Ave., St. Paul, Minn.

Lieut. Col. Fred S. Hird, Ord. Res.,
2615 Merle Hay Rd., Des Moines, Iowa.

Major Earle Buckingham, Ord. Res.,
27 Cedar Road, Belmont, Mass.

Major Alfred M. Cressler, Ord. Res.,
2 Interwood Place, Cincinnati, Ohio.

Major Charles E. Smart, Ord. Res.,
38 Maple Ave., Troy, N. Y.

Major Henry E. Suavet, Ord. Res.,
8907 96th St., Woodhaven, L. I., N. Y.

Capt. Richard W. Bond, Ord. Res.,
810 Franklin St., Wilmington, Del.

Capt. Ralph O. Cragin, Ord. Res.,
1715 Las Flores Drive, Eagle Rock, Los Angeles, Calif.

Capt. Stephen L. Goodale, Ord. Res.,
1156 Murrayhill Ave., Pittsburgh, Pa.

Capt. Timothy S. Mahoney, Ord. Res.,
8603 139th St., Jamaica, N. Y.

Capt. Edmund B. Moore, Ord. Res.,
Engr. Div., Curtiss Aeroplane & Motor Co.,
Garden City, L. I., N. Y.

Capt. Herbert M. Potter, Ord. Res.,
910 No. 11th St., Beatrice, Nebr.

Capt. Fred L. Rinkliff, Ord. Res.,
101 Western Ave., Chillicothe, Ohio.

Capt. Joseph G. Smith, Ord. Res.,
133 North Maple Ave., East Orange, N. J.

1st Lieut. Joseph E. Downey, Ord. Res.,
40 Broad St., Boston, Mass.

1st Lieut. Clarence B. Mills, Ord. Res.,
74 Kenwood Place, East Orange, N. J.

1st Lieut. John P. Mullen, Ord. Res.,
Penobscot Ave., Millinocket, Maine.

1st Lieut. Clarence H. Porter, Ord. Res.,
Apt. 22, 3120 R St., N. W., Washington, D. C.

1st Lieut. Augustus A. Wagner, Ord. Res.,
Route 8, Box 396, Portland, Ore.

1st Lieut. Alfred F. Witte, Ord. Res.,
S. W. Cor. Fairfield & Kinney Sts., Cincinnati, Ohio.

2nd Lieut. Theodore Bergstrom, Ord. Res.,
1414 West 62nd St., Seattle, Wash.

2nd Lieut. Lester E. Briscoe, Ord. Res.,
711 So. Milwaukee Ave., So. Milwaukee, Wis.

2nd Lieut. Clarence E. Burke, Ord. Res.,
44 Whitney Ave., Hapeville, Ga.

2nd Lieut. Everett S. Carpenter, Ord. Res.,
551 High St., Lonsdale, R. I.

2nd Lieut. Hiram E. Cassidy, Ord. Res.,
301 West Ave., 26, Los Angeles, Calif.

2nd Lieut. William R. Clark, Ord. Res.,
18 Jefferson St., A. C. L. R. R. Co., Jacksonville, Fla.

2nd Lieut. Charles K. Crofton, Ord. Res.,
care Rochester & Pittsburgh Coal & Iron Co.,
Rochester, N. Y.

2nd Lieut. Clarence C. Dean, Ord. Res.,
68 Perrine Ave., Pittsfield, Mass.

2nd Lieut. Roy J. Eide, Ord. Res.,
525 Securities Bldg., Des Moines, Iowa.

2nd Lieut. Townsend Foster, Ord. Res.,
1130 Parker Ave., Detroit, Mich.

2nd Lieut. Charles J. Gallagher, Ord. Res.,
712 Morton Ave., Chester, Pa.

2nd Lieut. Edward Gluck, Ord. Res.,
11011 215th St., Queens Village, N. Y.

2nd Lieut. Neal Graham, Ord. Res.,
7516 No. Seeley Ave., Chicago, Ill.

2nd Lieut. Nelson R. Knox, Ord. Res.,
2855 Ogden Ave., Milwaukee, Wis.

2nd Lieut. Elmo W. Landers, Ord. Res.,
631 Western Ave., Lynn, Mass.

2nd Lieut. Fairman B. Lee, Ord. Res.,
2707 10th Ave., W., Seattle, Wash.

2nd Lieut. Lloyd M. Littlefield, Ord. Res.,
261 Newbury St., Boston, Mass.

2nd Lieut. Harold W. Lyons, Ord. Res.,
26 Lane Park, Brighton, Mass.

2nd Lieut. Chester E. McCarty, Ord. Res.,
306 E. 39th St., No. Portland, Ore.

2nd Lieut. John H. Maddox, Ord. Res.,
care Florida Power & Light Co., Miami, Fla.

2nd Lieut. Ralph S. Nagle, Ord. Res.,
2844 27th St., N. W., Washington, D. C.

2nd Lieut. Bertram V. Nutt, Ord. Res.,
1600 29th St., Moline, Ill

2nd Lieut. Zimri C. Oseland, Ord. Res.,
1001 Ocean Ave., Brooklyn, N. Y.

2nd Lieut. Charles J. Piper, Ord. Res.,
3908 Terrace St., Kansas City, Mo.

2nd Lieut. William C. Platt, Ord. Res.,
2223 Meadow Valley Terrace, Los Angeles, Calif.

2nd Lieut. Glen O. Rinearson, Ord. Res.,
515 East 6th St., Claremore, Okla.

2nd Lieut. Irwin J. Schaie, Ord. Res.,
321 West 94th St., New York, N. Y.

2nd Lieut. Vaclav M. Schimek, Ord. Res.,
R. F. D. No. 4, Box 197, Columbus, Ga.

2nd Lieut. Harold D. Shierman, Ord. Res.,
11 Pine St., Springfield, Mass.

2nd Lieut. Robert E. Smith, Ord. Res.,
2745 Ridgeway Ave., Ensley, Ala.

2nd Lieut. Joseph W. Sterrett, Ord. Res.,
44 Olcott Ave., Buffalo, N. Y.

2nd Lieut. Stephen Terpak, Ord. Res.,
64 Springside Ave., Pittsfield, Mass.

2nd Lieut. Elmer J. White, Ord. Res.,
6515 23rd Ave., N. W., Seattle, Wash.

2nd Lieut. Robert A. Williams, Ord. Res.,
2275 Yale Ave., Maplewood, Mo.

Recently Assigned Ordnance Reserve Officers

THE following reserve officers have been assigned, as indicated after their names, since the last issue of ARMY ORDNANCE:

Col. Harry J. Scullin, Ord. Res., Manufacturing Service, St. Louis District Ordnance Office, St. Louis, Mo.
Lt. Col. Richard E. Cotton, Ord. Res., Territorial Assignment Group.
Lt. Col. Fred S. Hird, Ord. Res., Territorial Assignment Group.
Major Earle Buckingham, Ord. Res., Manufacturing Service, Boston District Ordnance Office, Boston, Mass.
Major Henry E. Suavet, Ord. Res., Territorial Assignment Group.
Capt. Richard W. Bond, Ord. Res., Manufacturing Service, Philadelphia District Ordnance Office, Philadelphia, Pa.
Capt. Ralph O. Craign, Ord. Res., Territorial Assignment Group.
Capt. Stephen L. Goodale, Ord. Res., Manufacturing Service, Pittsburgh District Ordnance Office, Pittsburgh, Pa.
Capt. Timothy S. Mahoney, Ord. Res., Territorial Assignment Group.
Capt. Edmund B. Moore, Ord. Res., Manufacturing Service, Watertown Arsenal, Watertown, Mass.
Capt. Herbert McP. Potter, Ord. Res., Territorial Assignment Group.
Capt. Fred L. Rinkliff, Ord. Res., Territorial Assignment Group.
Capt. Joseph G. Smith, Ord. Res., Territorial Assignment Group.
1st Lt. Joseph E. Downey, Ord. Res., Territorial Assignment Group.
1st Lt. Clarence B. Mills, Ord. Res., Territorial Assignment Group.
1st Lt. John P. Mullen, Ord. Res., Territorial Assignment Group.
1st Lt. Clarence H. Porter, Ord. Res., Manufacturing Service, Baltimore District Ordnance Office, Baltimore, Md.
1st Lt. Augustus A. Wagner, Ord. Res., Manufacturing Service, Ammunition Division (Inspector), Washington, D. C.
1st Lt. Alfred F. Witte, Ord. Res., Manufacturing Service, Cincinnati District Ordnance Office, Cincinnati, Ohio.
2nd Lt. Theodore Bergstrom, Ord. Res., Territorial Assignment Group.
2nd Lt. Lester E. Briscoe, Ord. Res., Territorial Assignment Group.
2nd Lt. Clarence E. Burke, Ord. Res., Territorial Assignment Group.
2nd Lt. Everett S. Carpenter, Ord. Res., Territorial Assignment Group.
2nd Lt. Hiram E. Cassidy, Ord. Res., Manufacturing Service, San Francisco District Ordnance Office, San Francisco, Calif.

Books

George Washington: The Image and the Man. By W. E. Woodward. New York: Boni and Liveright. 1926. $4.00.

GEORGE WASHINGTON is always interesting and worth reading about. Besides, no single book about Washington can give a proper picture of him because each author, no matter how honest, can but paint the picture as it appears to his eyes with the further limitation that successful biography must take into account the intellectual and emotional indices of the times. Mr. Woodward has written a very interesting book which is in harmony with our national age: we no longer believe in Santa Claus.

One of the rather unusual as well as most valuable features of this book is that the author has carefully reconstructed about his sketch of Washington the scene of his times. A lack of such treatment causes much of the present controversy about our dead leaders, which is meaningless just because it involves passing judgment on their acts with a modern code. Although the author does not indulge in sensational personalities or harp on inconsequential details, he tells convincingly that the Father of his Country was an aristocrat, a conservative in Colonial politics, a good business man, and one of the richest men in America at that time. He also shows that Washington was a man of great honor, a man of action rather than of ideas, and, most important, a very strong character with predominating moral and physical courage. The latter were undoubtedly his greatest qualities; they are the essential qualities of a great leader of men.

As the story unfolds it becomes increasingly clear that the United States was born and survived its infancy largely because Washington was such a man as has just been described and was neither an idealist nor a sentimentalist, as some of his biographers have described him. The following extract from one of Washington's letters, quoted by Mr. Woodward, indicates that there was probably no greater per capita patriotism in 1776 than in 1926: "* * * I know patriotism exists * * * but I will venture to assert that a great and lasting war can never never be supported on this principle alone. It must be aided by a prospect of interest or some reward." Like many other observations of Washington, this deals with men not as they ought to have been but as they were (and still are), and therein lies the value of what he had to say.

Mr. Woodward criticizes Washington's disciplinary measures in the Continental Army as too severe. One answer to the author is that the punishments were in keeping with civil opinion of that time; he relates on page 42 that a girl who stole Washington's clothes while he was swimming was convicted of theft and given fifteen lashes on the bare back. An answer of more general application is that the greatest unkindness to soldiers in war is a lack of just but strict discipline; Upton's "Military Policy of the United States" and Ganoe's "History of the United States Army" cite some interesting examples from our own history. Mr. Woodward cites Napoleon as a less severe disciplinarian than Washington, in answer to which I must say that some critics have considered the chief cause of Napoleon's disastrous retreat from Moscow to have been his lack of discipline in that city and on the march back.

The author makes clear what a fluctuating, complex and unorganized movement the Revolution was and in so doing emphasizes the fact that Washington supplied the essential unity that such a movement must have to be successful. He kept the spirit of the War of Independence alive while Franklin was bringing France into the war against England and the American privateers were helping immensely by their attacks on British commerce. After discussing Washington as a realist at some length the author says: "Washington possessed the superb self-confidence that comes only to men whose inner life is faint, for the inner life is full of nameless doubts. In the desperate days at Valley Forge, when the British held Philadelphia, and it seemed to most men that the American cause was slowly dying of cold and hunger, Washington wrote to John Parke Custis, 'lands are permanent—rising fast in value—and will be very dear when our independency is established'." Mr. Woodward brings out that Washington was a great executive rather than a man of great ideas by a comparison between the small part he took in events while the Revolution was an idea and the large part he took when actual revolution took place.

The distinctive thing about Mr. Woodward's work is, however, that he gives the economic interpretation to history; he takes the viewpoint that has been gaining authority slowly but very steadily only since Heeren, early in the 19th Century, first called attention to it. Such history is neither as inspiring nor as beautiful as the "old" history

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but we must, I think, grant that the "new" history is more reasonable and more in harmony with man as we know him. The author calls attention to the essentially economic nature of the trouble between England and the Colonies; he points out the effects of frontier life and the struggle for existence on men's ideas and the structure of society in the Colonies. But even in the cold grey light of such interpretation Washington stands out as the great leader who was truly the Father of his Country. There was sufficient greatness about Washington in his actual life to make it unnecessary for historians to delete or add anything. But while accepting Mr. Woodward's economic interpretation of Washington's life and times we need not subscribe to the author's opinions as to the social justice of the events or their motivation.

A comparatively short space is given to Washington as President, when what many consider his greatest achievements took place. During this period Washington kept the infant United States alive by keeping out of war with England and France; by backing Hamilton in making the government safe, stable and solvent; and by establishing important precedents for the future Chief Executives. Of course, this was the controversial period of Washington's career and there is hardly any middle course: we must choose between Hamilton and Jefferson in studying this part of our history. Washington was a Hamiltonian and I cannot escape the impression that Mr. Woodward is a Jeffersonian.

This book is a valuable contribution to the literature of Washington as well as of the Revolution. Every page shows that a great amount of careful work has gone into this biography and it is very interestingly written. While there can be little quarrel with the facts in this book there is throughout an undercurrent of disappointment that Washington was not a pure democrat, more like Jefferson. But Mr. Woodward's book must be regarded as one of the best of the many biographies of Washington. The volume is attractively printed and bound.

John K. Christmas.

Air Service, American Expeditionary Force, 1918. By H. A. Toulmin, Jr., New York: D. Van Nostrand Co. 1927. 388 pp. illustrated, 8 vo. $6.00.

THE author in the first paragraph of his Foreword states that, "The primary purpose of this book is to demonstrate the necessity of a preparedness program for our air force. The secondary purpose is to give credit, while sources of information are still available, to officers and men of our own and Allied forces for creating an American Air Service despite the relatively little assistance that part of this country charged with this duty rendered to our Air Service in France in time to be of any use."

The need for "a preparedness program for our air force" is a decided necessity, and the almost entire lack of such a program in the early part of the World War is now common knowledge. It would appear then that "the primary purpose of this book" would have been better accomplished if it had analytically shown what has been accomplished to this end and what additional provision should be made for proper preparedness.

The "secondary purpose" has been signally neglected in order to explain to the author's satisfaction the part he

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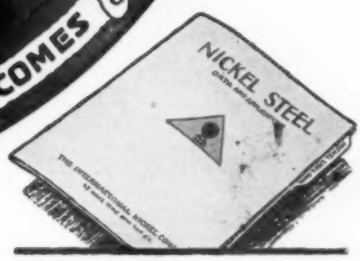

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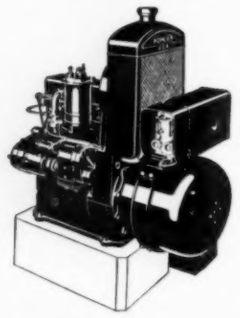

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played in the organization in 1918 of the Aircraft Armament Section of the Ordnance Department and of the entire Air Service in Europe. In his conception of the Air Service, A. E. F., the organization for supply predominates and the accomplishments of the ultimate product, the man in the air, is not extensively recorded.

The author has doubtless had ample time and opportunity to ascertain the true efforts put forth by the United States during the War and the accomplishments attained, so that there is no excuse for the apparent ignorance of the status of affairs as exhibited in such statements as: p. v. "the relative little assistance that part of this country charged with this duty rendered to our Air Service in France in time to be of any use"; p. 20, "largely dependent on the charity of our Allies for supplies and ships, ridiculous in the light of a fabled billion dollars appropriation from home with scant finances abroad"; p. 45, "the failure of the Air Service program to meet the demands of the Expeditionary Force was to be placed upon the Ordnance Department for a failure to provide adequate armament facilities"; p. 74, "The Air Service stood in May, 1918, practically a complete failure;" p. 75, "The (Air) Service lacked vision;" p. 313, "Apparently out of our vast resources the only thing which America produced in superfluous excess greatly ahead of all expectations, was the newspaper reports, presumably coming from distinguished officials, of what we were going to do, which afterwards turned out that we did not do at all. This especially hurt us by stimulating the enemy to extraordinary accomplishments, while we ourselves did not live up to a fraction of our boasted claims."

A better understanding of the facts is evidenced by the remarks of Col. H. Dunwoody in one of his reports:

"The development of the Supply Section must be viewed, not as a history of personalities, dates, or headquarters, but as the growth of an idea, by the difficulties overcome, and complex conditions of operation in a foreign country three thousand miles from the base of supplies. Unavoidably, we were frequently compelled to remain in semi-ignorance of the work being done at the base of supply, and forced to depend upon foreign production in order to bring success to the Air Service operations, especially during the first six months of effort."

For by that eminent authority Benedict Crowell, former Assistant Secretary of War and Director of Munitions, are we informed that the Congress appropriated about $700,000,000, which was not in the least ephemeral, for Military Aeronautics; that the use of Foreign supplies was a part of the plans of the Inter-allied Munitions Council and that for them the United States furnished raw materials on an equitable basis and did so furnish 450,000 tons in excess of our replacement obligations to France and by this arrangement caused a resultant saving of 2,000,000 tons of that scarce quantity, cargo space; that the production of munitions scheduled for 1918 was insignificant with the production actually scheduled by the Supreme War Council for 1919 and 1920; that this schedule was based on sound strategical reasoning, for, as scheduled, time was given to organize our manufacturing capacity so as to ultimately attain enormous quality production as opposed to early quantity of an indifferent class; and that the actual troop sailings exceeded on November 11, 1918, by about 400,000 men the number our program called for.

Arthur W. Ford.